The Electrical Industry's Weekly Magazine

January 16, 1961

Electrical World

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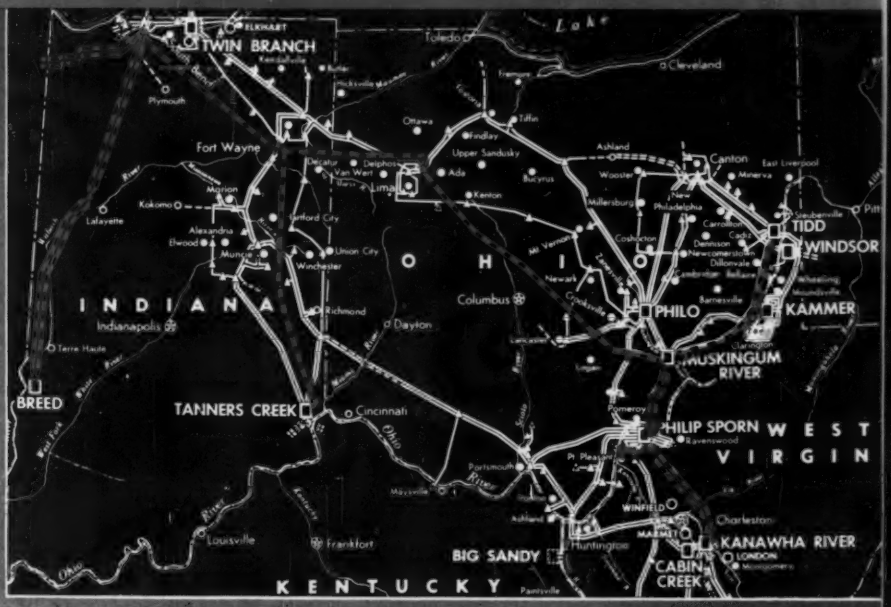

THE BREED PLANT STORY

32-Page Special Report

...page 47

UNIV MICROFILMS INC
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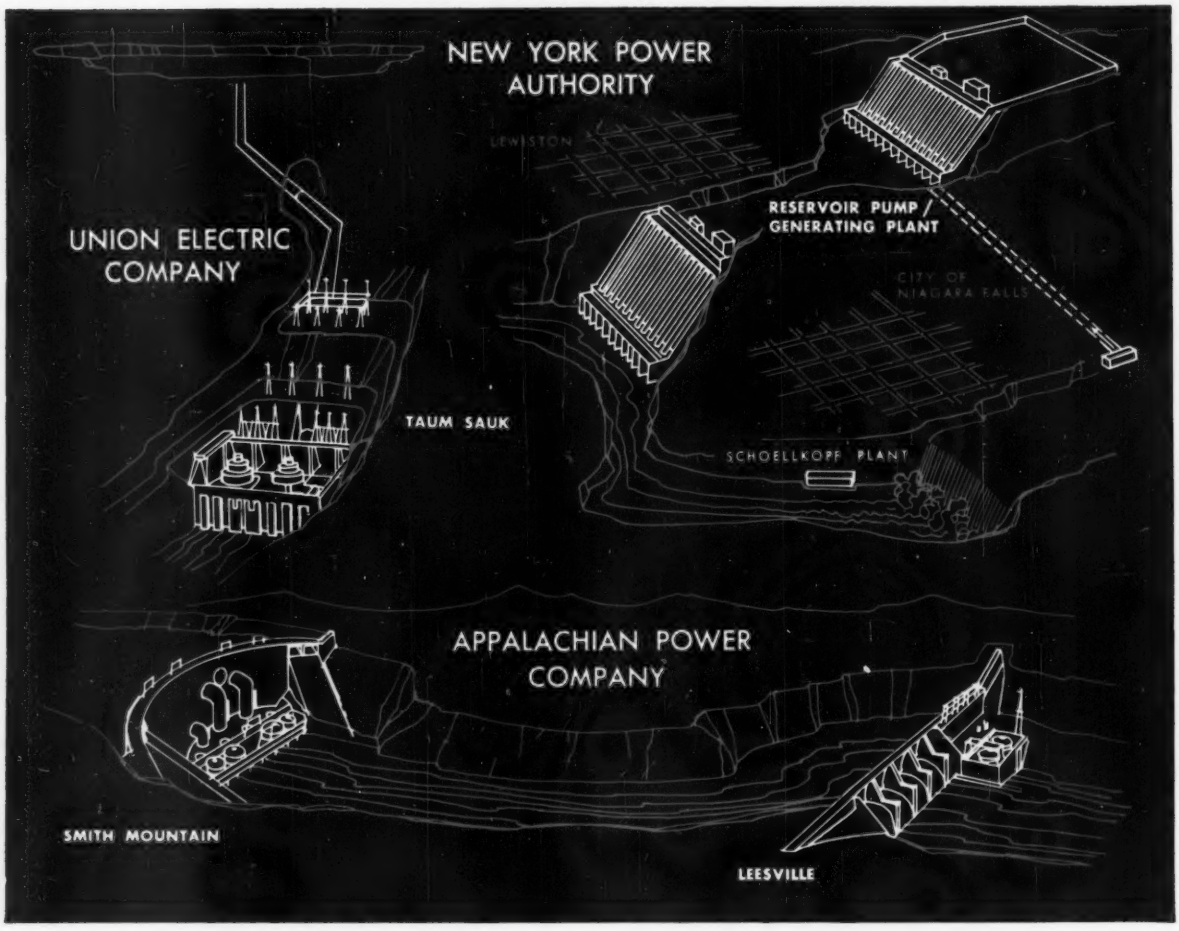
ALLIS-CHALMERS



Just what you'd expect from the pumped-storage pioneer:

first in all three

Pumped-storage power projects now under construction in this country all rely on Allis-Chalmers reversible pump-turbines. In fact, A-C is the only builder of complete reversible pump-turbine equipment!

First in boosting existing hydro at Niagara Reservoir pump/generating plant! This pumped-storage project will capitalize on the hydro-electric power potential of Niagara River without adversely affecting the scenic beauty of the Falls. Largest project of its kind, this installation will include 12 reversible pump-turbines with motor-generators . . . all designed and fabricated by Allis-Chalmers. As a turbine, each unit is rated 28,000 hp under 75-ft net head; as a pump, 3,400 cfs at 85-ft total head.

First in pure regeneration — at Taum Sauk! . . . also to have the largest-capacity hydro units ever built. Allis-Chalmers will supply two 175,000 kw reversible pump-turbines, each with a capability exceeding 300,000 hp under 800-ft head. (Pure regeneration installations need only a water supply to replace evaporative losses, so a creek is ample. Even a hill is unnecessary: the pool can be underground, in an abandoned mine shaft, for example.)

First in run-of-river — at Smith Mountain! This new project involves reservoirs at two successive levels, the lower dam forming a tailrace pool at the upper dam for two A-C reversible pump-turbines, each rated 87,000 hp at 180-ft head. Conventional hydro-generating units will also be installed — two higher-head units at the upper dam and two lower-head units at the lower dam.

For complete information on pumped-storage, hydro-generating equipment or other components for water control, contact your nearby A-C office. Or write to **Allis-Chalmers,** *Hydraulic Division, York, Pa.* A-1385

Published for 87 years for those engaged in the business of generating, transmitting, distributing, or applying electric power

Electrical World

JANUARY 16, 1961

Vol. 155, No. 3

Electrical What in the World . . .

In one very important respect the Editor of *Electrical World* is most fortunate: He is able to call on a staff of highly seasoned people—editors whose experience qualifies them very uniquely to turn out a magazine suited to the needs of you, the readers.

Surveys come naturally to these editors, but usually they're on the sending end. To turn the tables—and to satisfy my curiosity—I ran a survey on *them*. After sorting out the caustic comments, I found these interesting results to share with you.

We have 21 writing editors, averaging 39.2 years of age. The age median is 36; five admit reluctantly to being past the half-century mark, and four more are in their cherubic twenties. The average tenure with EW is only 5.4 years, but eight have served six years or more, and one has been with *Electrical World* for a total of 26 years.

Eighteen of the 21 have degrees, several more than one. And 12 degrees are in engineering.

We pick 'em from industry, without question. The gang aggregates 299 years of electrical industry experience, which works out to a 14.2 year average; the median is an even decade! This experience includes manufacturers, consulting engineers, utilities, and of course, *Electrical World*. Somewhere on the staff we can find at least a grain of working experience with virtually every segment of the electrical business.

Any wonder we are proud of this bunch?

Chuck Hochgesang

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FROGMEN CONFER ABOARD A CABLE-LAYING BARGE before installation of Okolite-Okoprene 5 Kv underwater power and Okolene supervisory control cables at Freeport Sulphur's off-shore sulphur mine in the Gulf of Mexico. These armored cables carry power and control circuits for the auxiliary drilling platform, where water is removed from sulphur deposits.

THE CABLE-LAYING BARGE moves past part of the Freeport Sulphur installation, "the world's largest steel island," where Okolite-Okoprene and Okolene-insulated cable were specified by company engineers for critical underwater circuits.

Freeport Sulphur chooses Okonite electrical cables for world's first off-shore sulphur mine

As in other installations where circuit security is a must, Freeport Sulphur engineers chose Okonite submarine power, communication and control cables for underwater circuits to the auxiliary drilling platform which makes possible continuous production at the company's giant, off-shore sulphur mine—first in the world—in the Gulf of Mexico.

Located 2,000 feet from the main structure, the auxiliary platform has a number of wells which remove the excess water from the deposit. The platform houses giant pumps and mixers for the safe disposal of this water.

Two armored three-conductor Okolite-Okoprene 5 Kv submarine cables and one armored 100-conductor Okolene-insulated cable carry all power, communication and supervisory control circuits to the isolated auxiliary platform, enabling control of all equipment from the main platform. In addition, an unarmored 100-conductor Okolene-insulated cable carries control and communication circuits for the main drilling platform from the control house.

The next time you require a cable for your circuits that must not fail, depend on Okonite Cable'bility* to provide you with the best cable for your needs. Why not check your Okonite representative for further information, or write for free Bulletin EW-1117, "How to Choose Insulated Cable," to The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, N. J.

*OKONITE Cable'bility . . . cable craftsmanship since 1878

where there's electrical power . . . there's **OKONITE CABLE**

7295-A REV

Letters

Meetings Conflict Worries Others, Too

To the Editor:

Your What in the *Electrical World* column in the Dec. 5 issue came through like a final deep breath of fresh air to a drowning man. It provides some hope and a little added strength, but whether or not it will get him out of this situation is almost too much to hope for. During the period from Labor Day to Thanksgiving, there were an estimated 75 traveling days for our firm, and we were unable to attend all the meetings that we would like to have and perhaps should have attended. You folks are probably called upon to attend many technical meetings in addition to this that we would not feel obliged to attend.

No doubt that the individual utility companies are likewise feeling the strain that you and we are, but certainly the solution is not to reduce the number of meetings. This would undoubtedly create an even more serious situation in the ever-present problem of communication and the solution of mutual problems on a common ground.

The Meetings Calendar in *Electrical World* is a step in the direction of avoiding meeting duplication, but it obviously is not used to its fullest advantage by the planners of meetings. Perhaps you would want to consider extending it into the future for six months or so, with the hope that it might be adopted as the vehicle for avoiding this heavy concentration of industry meetings during these periods.

For whatever consolation it might be, you folks have much company in this situation.

John E. Hamrick, Assistant to President
Reddy Kilowatt, Inc

To the Editor:

Regarding your column in the Dec. 5 issue of *Electrical World* on the spring and fall peaking of meetings and conventions—what can be done about it?

National-type meetings come out pretty well on scheduling. Regional meeting dates may overlap—as did the American Power Conference and the Southeastern Electric Exchange meeting.

But these are regional and don't we who are nationally oriented have to adapt ourselves accordingly?

Dick Cutts
General Electric Co

Dateline . . .

WASHINGTON, D. C.—Fierce competition between electric power and natural gas on the retail level lies behind the battle shaping up over a natural gas pipeline between south Texas and the Los Angeles area, through Mexico.

Southern California Edison Co has bought gas from the King ranch in Texas from Humble Oil & Refining Co. The big electric utility wants to haul the gas through a $225-million pipeline system backed by Tennessee Gas Transmission Co and the Mexican national oil company, Petroleos Mexicanos.

Lining up against the project's backers are the gas utilities in the Pacific Lighting System, and the interstate pipelines that now serve southern California.

Life or death for the Mexican line is in the hands of the Public Utilities Commission of California and the Federal Power Commission here.

Two key issues will face these agencies:

- Should such a huge supply of gas (an eventual total of 455 million cu ft daily, including gas from Mexico) be burned in boilers to make electricity?
- Should the Pacific Lighting System and the long lines to California be deprived of their chief off-peak (warm months) customer?

The Federal Power Commission has become more and more concerned over the "inferior use" of gas for boiler fuel. It has denied several deals somewhat similar to Edison's on grounds that the scarcity and advantages of gas make it essential that it go to smaller, firm customers, if possible.

The loss of their chief interruptible customer, the Pacific Lighting companies say, will disrupt the economics of the gas business in southern California, and bring higher rates to firm customers.

Recent rulings of the FPC seem to support these arguments against the Mexican pipeline.

(*Continued on page* 45)

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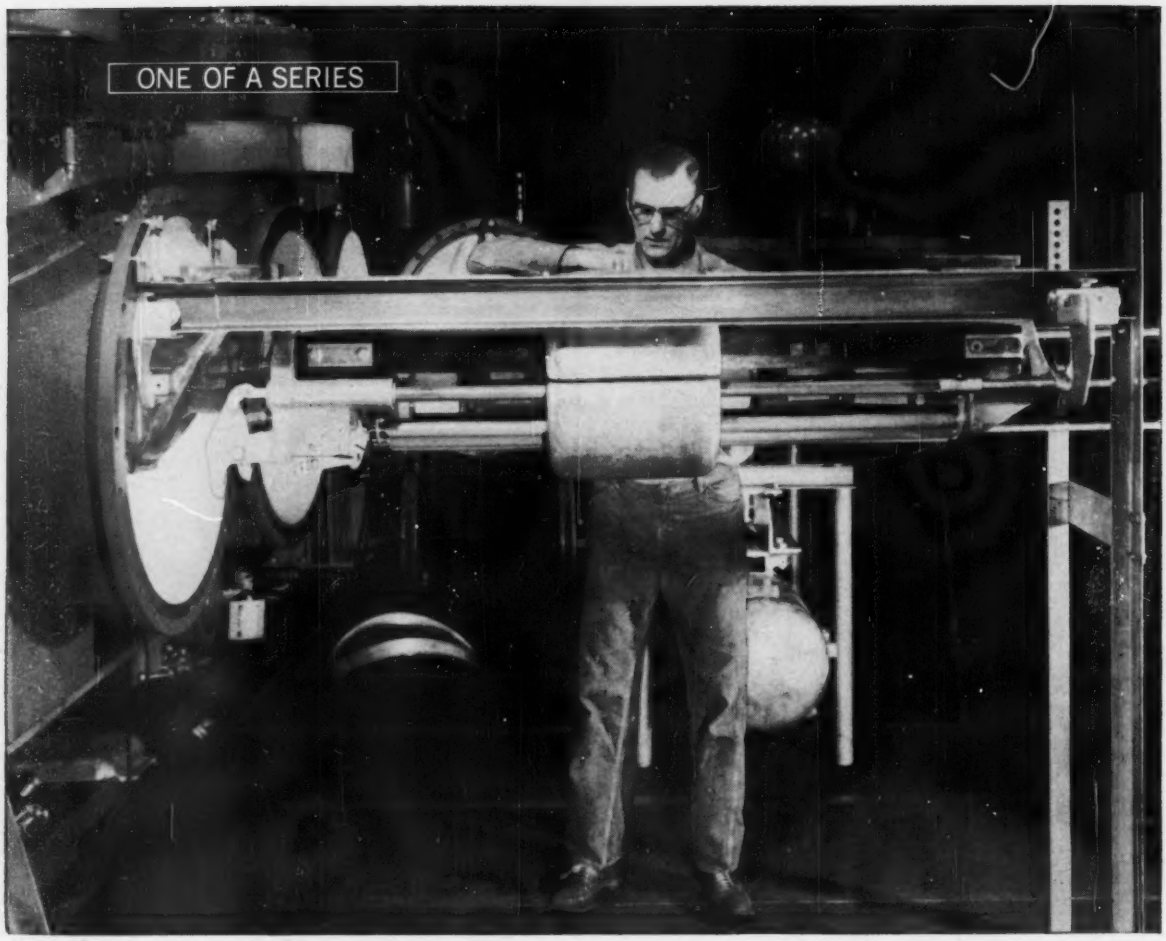


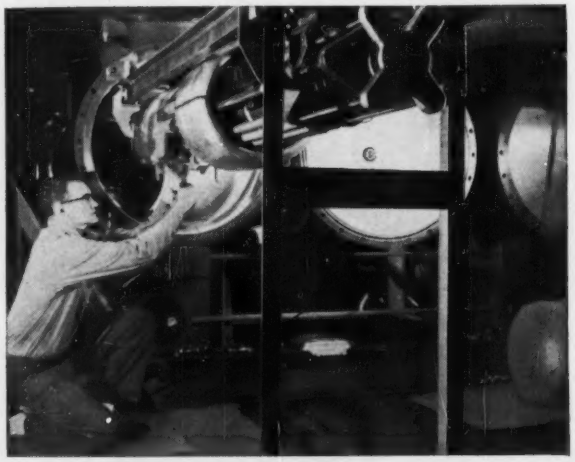
New, Easy, Ground-level Inspection of SF_6 Gas Breaker Slashes Maintenance Costs

provides greatly improved performance from 69 to 460 kv and beyond

A unique horizontal interrupter design in the new Westinghouse gas power circuit breaker now brings the interrupters within easy reach of the maintenance man. No scaffolds, block and tackle or ladders are required to inspect breaker contacts. Now workmen can perform all maintenance comfortably . . . from the ground!

The interrupter can be removed from each tank of the Westinghouse breaker in just 15 minutes.

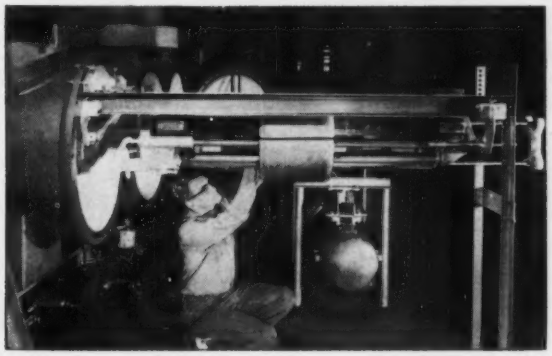
After evacuation of the SF_6, a set of lightweight aluminum rails is installed inside the pole unit. Trolleys are attached to the interrupter; bolts are removed at the bushings, operating rod and high-pressure tube. The interrupter can then be pulled out for inspection. There is no heavy equipment to be lifted! There is no easier way to remove an interrupter.



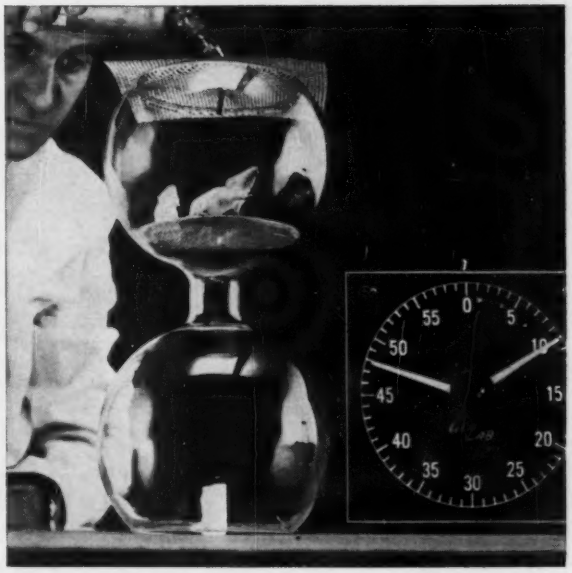
Operation of the interrupter is easily checked by attaching a jack and opening and closing the contacts by hand. This convenient operation-check is another cost-saving advantage over other breaker designs.

The advanced interrupting techniques developed in this new gas breaker, improved contact design and efficiency of the SF_6 (sulfur-hexafluoride) interrupting medium combine to *reduce the need* for periodic maintenance to a fraction of present accepted practice. *Over-all* maintenance costs of the Westinghouse gas breaker are estimated to be less than half those of other breakers.

Extensive field and laboratory experience (since 1953) has proved that SF_6 is completely safe to use



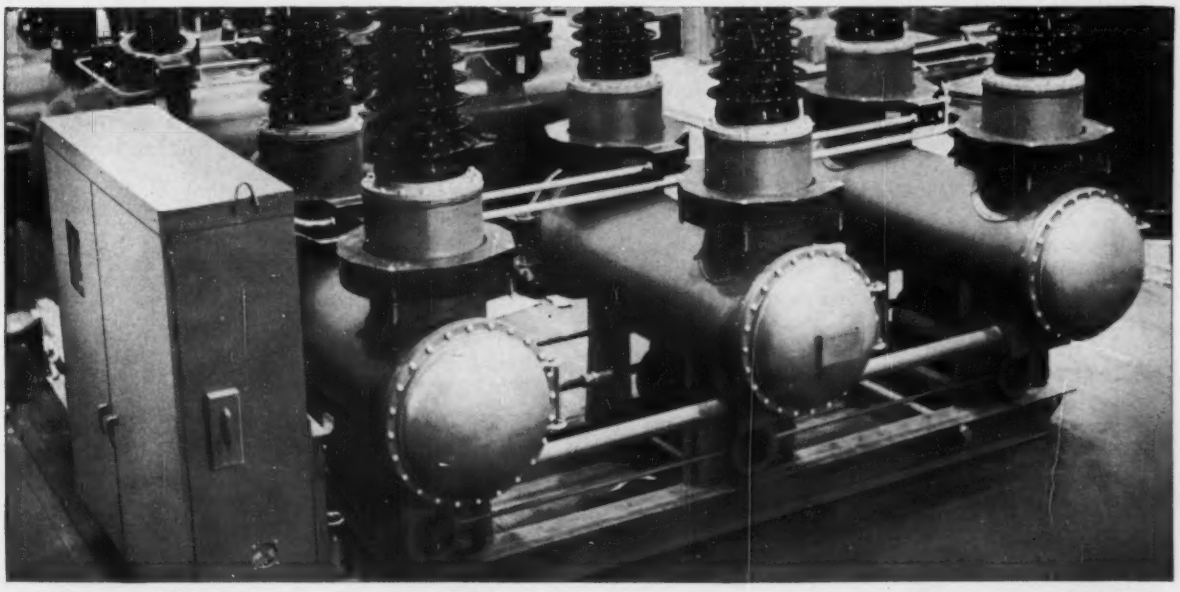
without any harmful effect on personnel. Only precautionary measures of the common-sense variety are recommended. The gas is carefully filtered by activated alumina, as it is circulated in the breaker high- and low-pressure systems, to remove any gaseous arc products. Any solid arc products left in the pole unit after evacuation can be quickly blown out



with compressed air.

This inert, nonflammable, nontoxic gas is heavier than air as demonstrated in the laboratory experiment above. The SF_6 sinks to the bottom, snuffing out the candle. Tests show that the mice can live in a mixture of 80% SF_6 and 20% oxygen for 24 hours without ill effect.

To learn more about the way the Westinghouse gas breaker can cut installation and maintenance costs and increase breaker performance, call your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. J-61006



Westinghouse Gas Breakers for Improved Performance from 69 to 460 Kv and Beyond

Westinghouse

Save on construction costs with the new '61 FORD TRUCKS

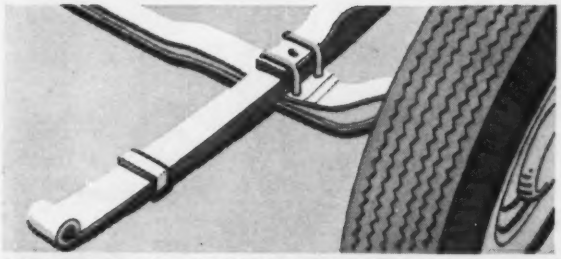
SAVE FROM $52 TO $221 ON PRICE* ALONE WITH FORD'S ECONOLINE PICKUP

Profit-conscious contractors are finding it's good business to do business with the new Ford Econoline Pickup. It's America's lowest-priced* pickup—bar none! Priced from $52 to $221 below other cab-forward economy pickups. But that's just the beginning! You get lively performance and proven gas economy with the popular Falcon Six. This modern engine goes 4,000 miles between oil changes, and has an aluminized muffler which lasts up to three times as long as ordinary mufflers.

And you can save more because Ford's functional design has pared away 1,000 pounds of dead weight, yet you still get the payload capacity of standard ½-tonners. The big 7-foot box provides a whopping 73 cubic feet of loadspace . . . that's up to 23% more than conventional 6½-foot pickups. A full 49-inch tailgate opening means you can load items like standard sheets of 4′ by 8′ plywood. And the full-length *flat* floor permits bulky or heavy loads to be positioned easily by sliding them anywhere in the pickup box.

And you can save on maintenance expense, too. The large engine cover can be lifted quickly, exposing the entire engine for rapid service. Spark plugs, distributor, etc., are conveniently located to speed engine tune-ups. And many major repairs can be made without ever removing the engine. One-piece cab-and-body construction provides increased rigidity and eliminates a major source of rust. In addition, all main underbody structural members are heavily zinc-coated to resist rust and corrosion.

**Based on a comparison of latest available manufacturers' suggested retail delivered prices*



SAVE UP TO $150 ON FRONT TIRES! In certified tests of truck suspensions, Ford front tires lasted up to twice as long. In 50,000 miles savings can add up to $150 on a pickup . . . more on two-tonners. And Ford's sturdy I-Beam front axle and leaf-spring suspension not only cut tire wear, but their simpler design also cuts maintenance costs.

12,000 MILE OR 12 MONTH WARRANTY

SAVE WITH GREATER DURABILITY . . . on all 1961 Ford Trucks, each part, except tires and tubes, is now warranted by your dealer against defects in material and workmanship for 12 months or 12,000 miles, whichever occurs first. The warranty does not apply, of course, to normal maintenance service and to the replacement in normal maintenance of parts such as filters, spark plugs and ignition points. Never before have you had such protection . . . such evidence of long-term economy!

SAVE WITH FORD'S NEW 262-CU. IN. "BIG SIX" ALL-TRUCK ENGINE FOR TOP PERFORMANCE AND ECONOMY

America's lowest-priced* medium-duty tilt-cab models now offer a big 262-cubic-inch Six with the power of big displacement, the gas economy of 6-cylinder design, plus the durability of heavy-duty construction. This engine features a sturdy stress-relieved head and block, strong forged steel crankshaft, long-lasting stellite-faced intake and exhaust valves and durable pyramid-type connecting rods. Positive Crankcase Ventilation reduces oil dilution and sludge formation to extend engine life. Ford's proven 292 V-8 and 292 HD V-8—the V-8's with "six-like" economy—are also available for your special power needs.

The popular Ford Tilt Cab Series outsells all other makes and for good reason! Their compact 82-inch BBC permits longer bodies within a given over-all length . . . for longer loads of lumber and building materials with excellent maneuverability. And set-back front axle design means more weight is carried on the front axle for greater payloads.

You also save with other new features like the stronger radiator with new lock-seam construction, and color-coded printed instrument panel electrical circuits that provide for greater reliability and simplified maintenance. In addition, Ford's parallel ladder-type frame, with standard 34-inch width, allows you to install new or transfer your present special construction bodies quicker and for less.

FORD TRUCKS COST LESS

YOUR FORD DEALER'S "CERTIFIED ECONOMY BOOK" PROVES IT FOR SURE...

FORD DIVISION, Ford Motor Company

PENNSYLVANIA UNIT SUBSTATIONS

a product of

togetherness

***developed together.** Pennsylvania Transformer, for over 30 years a quality manufacturer of substation components and assemblies, recently introduced a complete line of Secondary Unit Substations.

Through surveys and through a series of meetings with industry, we established what design features you wanted most. Then began the process of incorporating these features into a completely new, integrated unit substation.

We established a new facility, staffed with both transformer and switchgear specialists who were assigned the responsibility of together developing transformers and switchgear for these unit substations. There was no temporary borrowing of engineering talent, no face-lifting of existing components to do a new job. From the ground up, we created a new design to do a better job because, instead of piecemeal or multi-plant design, we had togetherness of development. Each part of the new Pennsylvania Unit Substation series is coordinated to function together with other integral parts; this gives you:

. . . Simplicity of field installation and connection
. . . Ruggedness and dependability in operation
. . . Ease of access for maintenance and adjustment
. . . Flexibility for modification and expansion

Our handbook No. PSG-559 provides engineering and application data on Pennsylvania Secondary Unit Substations. Write Unit Substation Department, Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pennsylvania.

*developed
engineered
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tested
shipped
serviced

together

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JANUARY 16, 1961
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LATE NEWS ▶ **Pennsylvania Electric** files with state's Public Utility Commission for approval to purchase Home Electric Co's franchises and properties in three boroughs. Penelec now supplies all the power which Home Electric distributes to 6,144 customers . . . **Toledo Edison** offers Bryan, Ohio, $3,135,100 for its municipal power plant, distribution system and related facilities. Bryan has been considering either expansion of the municipal system or finding an alternate supply of power . . . **Dayton Power and Light Co** is all set to buy Greenfield, Ohio's municipal system. But an "eleventh hour" suit by a Greenfield taxpayer, charging the price is inadequate, may block the purchase. Suit is another in a long series of legal moves aimed at stopping the sale.

REA approves $18.7 million loan to Southern Maryland Electric Co-op, Hughesville, Md., for construction of 99-Mw steam plant and 23 miles of 69-kv transmission line. The plant, at Marsh Point, Md., will comprise three 33-Mw units and begin operation in 1963. The co-op which serves about 25,000 customers, currently buys power from Potomac Electric Power Co. Prior loans to the co-op total about $13.8 million, of which about $2.9 million has been repaid.

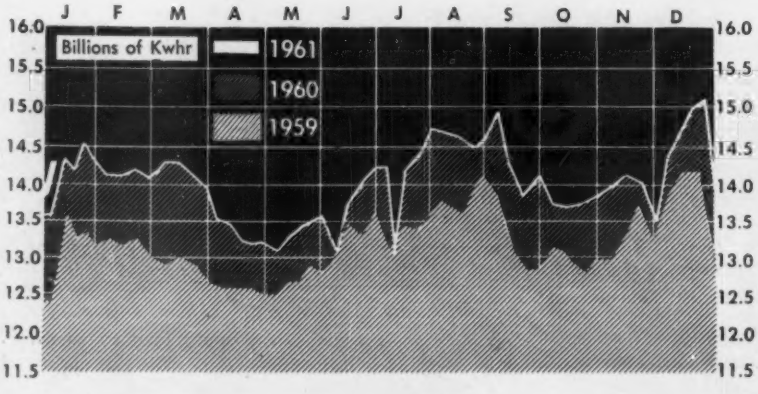
World's fastest air blast breaker, a 345-kv unit which can clear 25-million-kva short circuits in two cycles, will be used on American Electric Power Co's transmission net. Five of these GE breakers will be installed in 1962. Faster fault clearing aims at restoration of service in about ⅓ sec. . . . **AEP also announces purchase** of two 75-Mva synchronous condensers, one from the Elliott Co, the second from English Electric.

Seven utility chief executives will guide EEI's new Research Division. Willis Gale, chairman of Commonwealth Edison, is head of the Committee. Other members are P. A. Fleger, Duquesne Light; R. A. Gibson, Hartford Electric Light; J. K. Horton, Southern California Edison; D. C. Luce, Public Service Electric & Gas; W. W. Lynch, Texas Power & Light; and W. O. Turner, Louisiana Power & Light.

National Labor Relations Board finds Satilia Rural Electric Membership Corp, Alma, Ga, guilty of interfering with IBEW efforts to organize the co-ops employees. Board says the co-op erred when it sought to help employees revoke authorization cards they had signed favoring union representation.

Decline in weekly power output figures reflects New Year's Day holiday during the week. Week used last year had five full working days.

***WEEKLY POWER OUTPUT*—Down 0.4%** (Week ending Jan. 7), Kwhr 14,245,000,000



Per Cent Change From Previous Year

	Dec. 24	Dec. 31	Jan. 7
Total U. S.	+13.2	+ 2.9	— 0.4
New Eng.	+14.1	+ 6.2	— 0.7
Mid. Atlan.	+10.3	+ 5.3	— 3.0
Cent. Indust.	+ 8.4	— 2.8	— 7.8
West Cent.	+17.0	+ 4.2	— 0.4
Southeast	+19.7	+ 5.1	+ 3.8
South Cent.	+13.8	+ 3.8	+ 3.2
Rocky Mount.	+23.1	+12.9	+10.7
Pacific			
NW	+12.0	+ 2.9	+10.2
SW	+10.6	+ 3.1	+ 0.4

Seasonally Adjusted Index 277.7

Week Ago 277.5 Year Ago 264.5

Source: Edison Electric Institute

Supply Lines

HOW ELECTRIC UTILITIES LOOK AT FOREIGN BUYING

Large electric utilities take a rather dim view of foreign buying. This position is evidenced much more firmly in practice than in fixed policies. There is some indication that utilities which have bought a few selected items on the foreign market will be less inclined to repeat in the immediate future. These conclusions are drawn from talks with purchasing men in 15 large utilities in the Northeast, Midwest, and South during December. Reports from *Electrical World* editors surveying foreign buying policies and practices disclose the following:

Many utilities have not considered foreign buying of sufficient significance to warrant a fixed, written policy. Nine of the 15 utilities questioned said they had no policy of any kind. Two reported flexible policies. Two had firm "buy American" policies. One declined to respond. And another said a written policy was in the making.

When it comes to actual buying, the picture becomes clearer. Twelve of the 15 have done no buying abroad—or at least not in the past few years. One tried out a couple of foreign automobiles, but strictly on an experimental basis. Another has done some buying of selected items, but reports that this is now easing off. The third has bought some highly specialized items but indicates that such buying is coming under closer scrutiny.

Two factors in the current economic situation appear to be working against foreign purchases by electric utilities. One is the worry that every foreign purchase will intensify the gold outflow. Two utility purchasing men brought this into the conversation. The other is that domestic prices are now so favorable that foreigners have a harder time competing. Among the individual comments on foreign buying were these: "It would take a highly favorable deal to attract us." "We have had nothing interesting enough to consider." "We don't believe in it." "US prices are more reasonable." "We will, of course, review our stand as changes occur."

On every hand there were reports of foreign supplier activity. All utilities contacted indicated they had been approached by foreign sellers, and many had received offers in several product areas. Some of the firm buying policies appeared to have arisen from this persistent activity on the part of the foreign suppliers. In one or two instances some keen interest on the part of a top utility official had led to study and consideration of foreign products.

UTILITIES CHART 40% GAIN IN FOSSIL FUEL USE

Electric utilities will chalk up a 40% increase in consumption of fossil fuels by 1965 according to the preliminary results of a survey being conducted by Keystone Coal Buyers Manual. The McGraw-Hill publication survey indicates that in 1965 electric utilities will be using the equivalent of 362 million tons of coal in their boilers. This compares with 262 million tons used in 1960. Gas and oil are included along with coal in this fossil fuel figure, but are expressed in terms of coal equivalent.

In 1965, electric utilities will require about 72 million tons more of coal, and in terms of coal equivalent, 19 million tons more of gas, and 9 million tons more of oil than in 1960. Although tonnages vary widely, the percentage of growth for all three fuels is about the same. This is a significant change from the past

five years when growth was about 28 million tons, being made up of 20% growth for coal, 50% for gas, and 15% for oil.

In looking at geographical areas, growth for oil shows up only in Florida and California. Growth for gas will occur almost entirely in the Pacific and Southwest regions. Growth for coal will occur in all regions except the Pacific and Southwest, according to the survey. Rates of increased coal usage are as follows: 200% for the Mountain Region; 50% for South Atlantic and West North Central; 30% for East North Central and East South Central; 20% for Middle Atlantic and New England.

Three new utility customers for coal are seen. These are Arizona Public Service Co, Arkansas-Missouri Power Co, and City of Colorado Springs. These are now almost 100% gas users.

Gas and oil have won the battle of the fuels in at least one significant area. Consolidated Edison Co has ordered two 380-Mw units, oil and gas fired, for the new Ravenswood plant scheduled to go on the line in 1963. Coal burning equipment may be added at a later date. Hydro appears in the competitive picture for the first time in some years as northern New York utilities begin to take energy from the vast Niagara power development. This will decrease their coal burn by about 1½ million tons in 1961 and 2 million tons in 1962.

PRICES REVISED ON MOTORS, SOME GENERATORS

Revised and simplified pricing policy for large induction motors and synchronous motors and generators has been announced by General Electric Co. The revision involves price changes, by ratings, which result in a range of price increases up to 6% and price decreases of 20% across wide lines of motor ratings from 150 to 50,000 hp. New price listings have been condensed to two printed sheets, which will replace information previously requiring 22 pages. One feature of the new listings is that the published prices are net prices to users with a single discount applying to original equipment manufacturers in recognition of their services to user customers.

FLEET LEASING GAINS IN ELECTRICAL INDUSTRY

Leasing of auto and truck fleets is gaining in the electrical industry, but figures are not available for the utilities separately. Value of auto and truck fleets leased by the industry in 1960 is set at $54.9 million by Wheels, Inc, a national vehicle leasing organization. This is a gain of approximately $6.5 million over 1959. Total value of auto and truck fleets leased by all US industry in 1960 was $1.54 billion, a 12-month gain of $195 million, according to the Wheels estimates.

For the electrical industry, the biggest gains were registered in truck leasing. Firms in this industry leased 3,300 trucks last year, 17% more than in 1959. Auto fleets leased by the industry totalled 18,000 cars, an increase of 13%. The greater variety of lease plans made available to fleet operators was said to be an important factor in the gains made by leasers.

Enjoy the best Protection

The best protection you can buy is the Thorex Station Class lightning arrester. A measure of good protection is promptness with which an arrester can divert the lightning surge without affecting normal service. Here Thorex excels because it has the lowest IR discharge voltage of any arrester and is unique because it extinguishes the 60 cycle follow current arc well before voltage-zero.

Because the Dynagap (current limiting gap) so promptly extinguishes the arc, the silicon carbide valve blocks heat up very little. With its greater thermal durability, the arrester can withstand greater and longer surges than ever before. That means you can depend on the arrester for protection of important apparatus and circuits.

O-B Station Class arresters from 3 kv to 276 kv have one-piece continuous porcelain housings. Air-borne contamination, a major problem in many areas, has no damaging effect on the Thorex arrester's internal protective circuit since external leakage currents only bleed harmlessly down the outside. Also, Thorex station class arresters can be washed while energized with the same safety as other station insulation.

Enjoy the confidence that comes with using O-B Thorex Station-Class lightning arresters on your apparatus. They are backed by a name that inspires confidence:

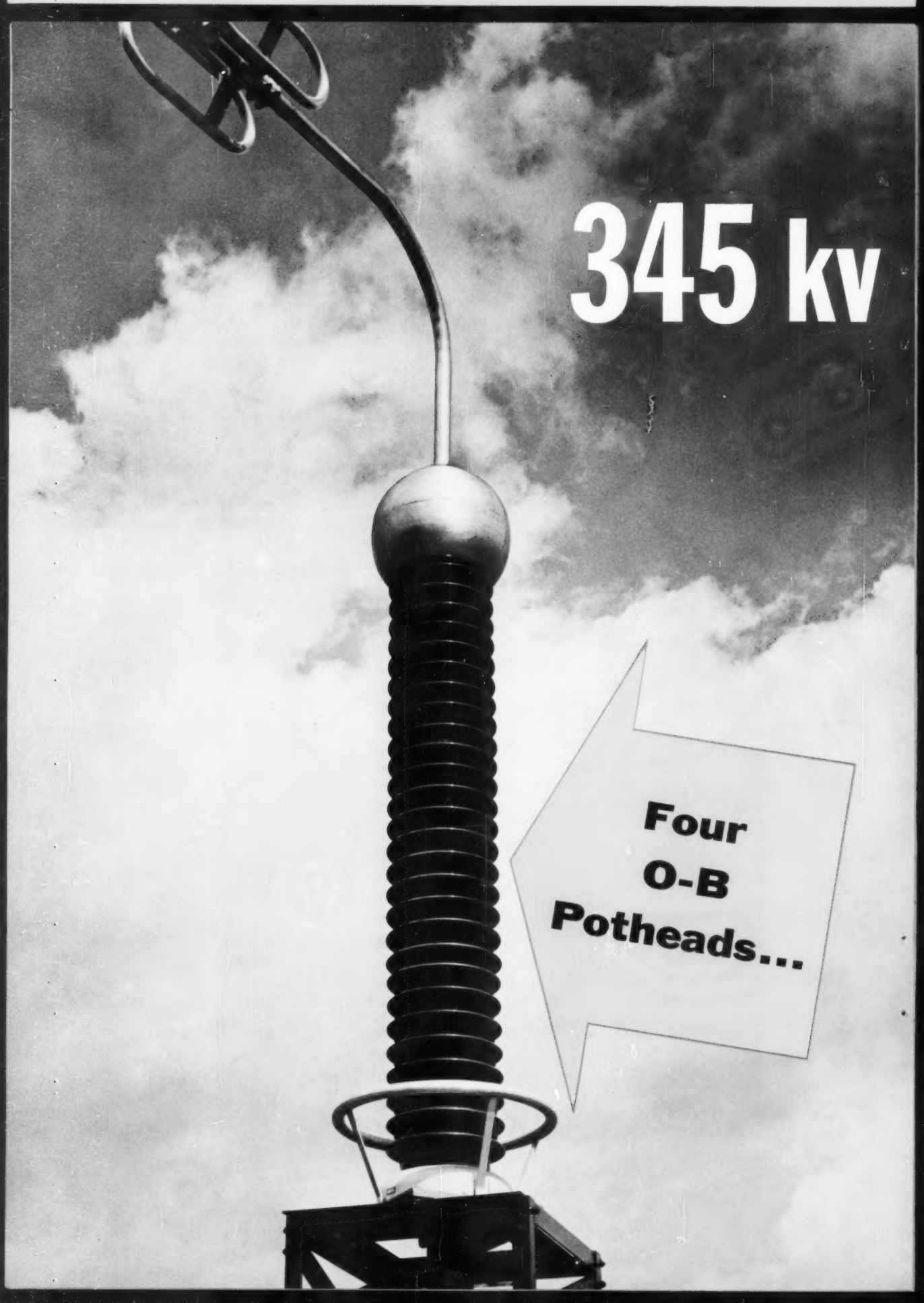
OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass (B) HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

10014-H1

Guard your important apparatus and circuits with Thorex station class arresters


345 kv
Four
O-B
Potheads...

Goes Underground

Four new O-B Potheads terminate one end each of four cables designed for 345-kv underground transmission. Test is sponsored by AEIC-EEI with the cooperation of Cornell University and several manufacturers of cables and apparatus, including Ohio Brass Company.

O-B's new capacitor-graded potheads are making an important contribution to the EHV test program. At extra high voltages, the electrical stress problems become complex, but O-B potheads give precise control over the radial and longitudinal stresses through series-connected capacitors and an accurately-formed stress cone.

Practical installation is another key feature of the O-B Pothead. The use of factory-assembled parts simplifies the installation procedure keeping field-installation time at a minimum.

This pothead was designed for 345 kv, but the same features are available in lower voltages. We will be glad to supply you with more details.

OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass

HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
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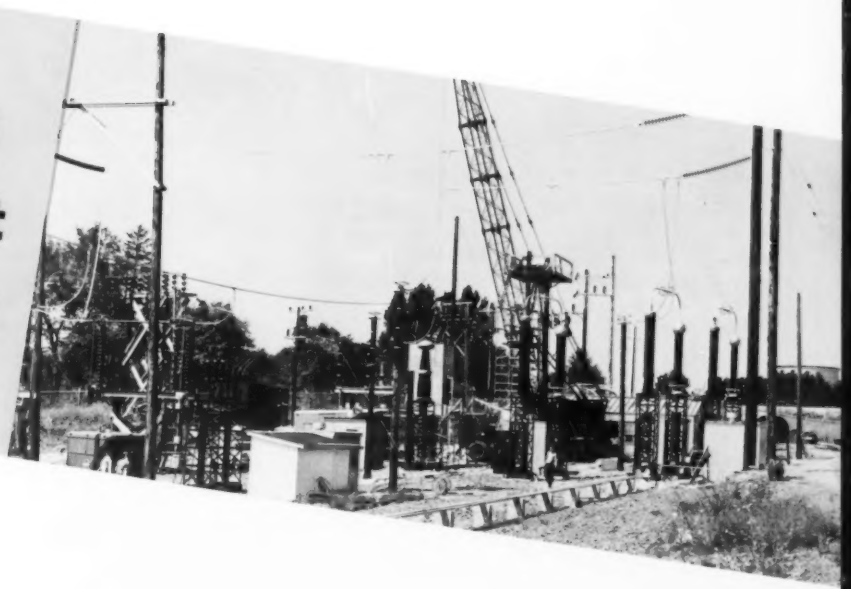
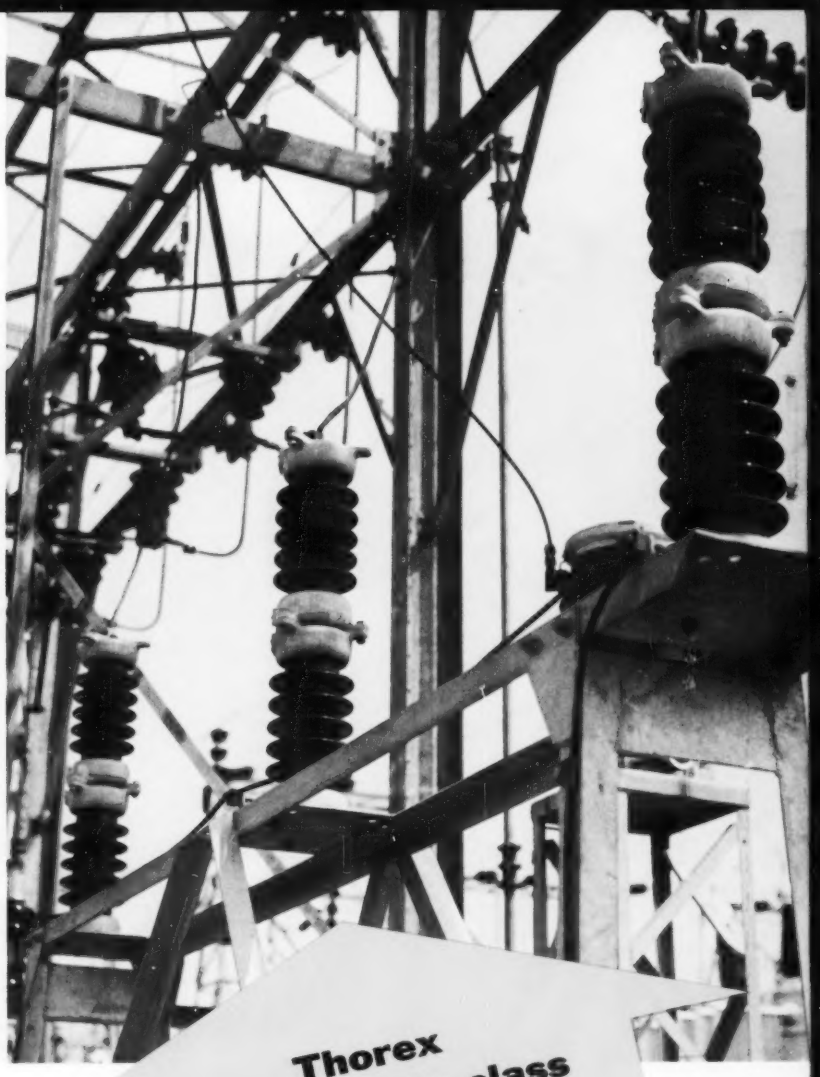
10014-H23

...installed on cables at Cornell test



Save arrester dollars



Thorex Intermediate class offer lightning protection at low cost

O-B's Thorex Dynagap Intermediate Class arrester gives you maximum protection and durability for your arrester dollar. Since it enjoys the use of many heavy-duty Thorex Station Class parts, the Thorex Intermediate Class arrester exceeds even the ASA standard station class performance requirements in many of the essential categories . . . and sells at about half the station class price.

Thorex Intermediate Class arrester substantially exceed the low-current, long-duration durability requirements of ASA standards for station class arresters. It easily passes industry requirements of 65,000 amperes on the high-current, short-duration test. Its sparkover and IR discharge voltage values are the lowest of any intermediate class arrester.

These arresters are available in line-to-ground ratings of 3 kv to 121 kv covering normal operating voltages of 2,400 to 138,000 volts. Heights range from 10¾ to 108½ inches.

Are you planning new stations but are having the budget conflict with your need for protection? Or are you considering arresters for older apparatus? You can specify Thorex Intermediate Class arrester with confidence - - no other arrester gives you greater protection and greater durability for your arrester dollar.

OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass

HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

10014-H4

Pre-Engineering by KAISER ENGINEERS answers basic plant expansion questions...

Timely? Many complex factors shape the final decision to proceed with your expansion plans...and timing is an important one. Independent analysis of all aspects of your proposed program is the *Pre-Engineering* service offered by Kaiser Engineers. The studies and evaluations furnished by KE Pre-Engineering represent only one phase of total KE services. Kaiser Engineers designs and builds all types of power plants—steam-electric, gas turbine, combined cycle, nuclear, and hydro-electric. From Pre-Engineering through design and construction, Kaiser Engineers provides complete, one-company service and ingenuity based on years of experience.

KAISER ENGINEERS

KAISER ENGINEERS engineers-contractors
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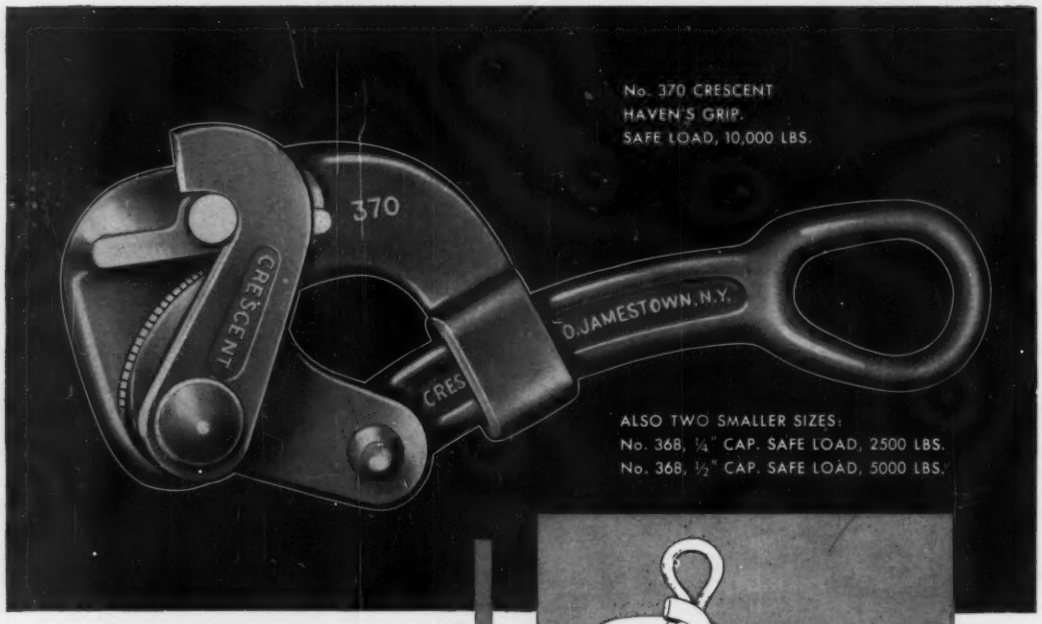
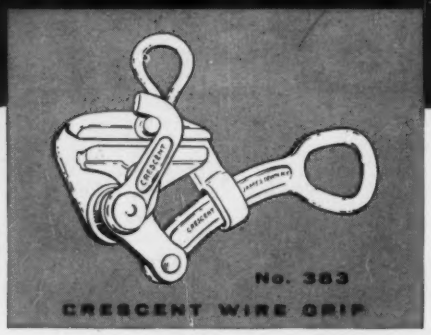
6228-P

Here's a NEW LARGE CAPACITY CRESCENT HAVEN'S GRIP



● No. 370 Haven's Grip has been added to the Crescent line in answer to insistent demand for greater capacity in these proven grips. Its capacity of 9/32" (.282) to 13/16" (.8125) will accommodate many sizes and types of wire.

Note that this grip incorporates a safety latch which not only prevents it from falling off the wire, but adds greatly to its structural strength. Like all Crescent Grips, No. 370 is forged from special alloy steel, carefully heat treated and finished in Cadmium plate.



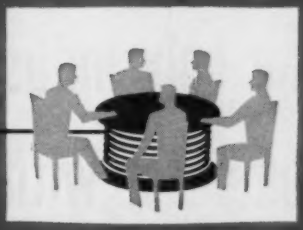
Parallel jaws assure a positive grip that will not injure wire. Jam-proof, instant releasing. Four sizes, with either smooth or serrated jaws, 5/16" to 1-1/16" capacity — up to 12,000 lb. safe load.

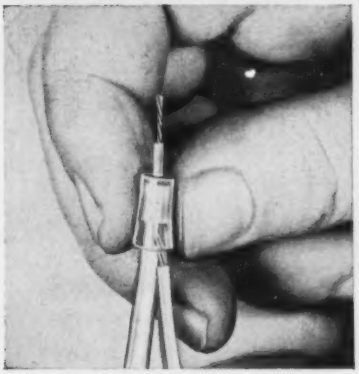
Crescent is our trade-mark, registered in the United States and abroad, for wrenches and other tools. Sold by leading distributors and retailers everywhere and made only by

CRESCENT TOOL COMPANY, JAMESTOWN, NEW YORK

WIRE AND CABLE ROUND TABLE

DU PONT





One-piece Burndy connector gives fast, reliable compression

Fast and reliable connections are possible with the one-piece UNIRING, molded of ZYTEL by the Burndy Corp., Norwalk, Conn.

Since these are compression connectors, there is no heat needed, and thus no danger of overheating cable. This also means no slow, bulky solder joints. The completed UNIRING assembly is only a few mils larger than the cable diameter.

UNIRING is available both insulated and uninsulated for single shielded cables, multi-conductor shielded cable and coaxial cables. They are also color coded for easy identification.

The Burndy sheath connectors are another example of the versatility possible with ZYTEL nylon resins. For more information to help you evaluate ZYTEL for your needs, write to the address at the right of this page.

Du Pont does not manufacture wire and cable, but supplies thermoplastic resins to the wire and cable industry.

POLYCHEMICALS DEPARTMENT

DU PONT

Better Things for Better Living...*through Chemistry*

New shipboard control cable uses ZYTEL® for resistance to cut-through, chemicals and moisture.

This naval destroyer, the USS Wilkinson, is equipped with modern, anti-submarine missiles controlled by cables protected with Du Pont ZYTEL nylon resin. (OFFICIAL U.S. NAVY PHOTO)

ZYTEL 33 and 37X help protect the Navy's "MOHOS" cable used to control the Mark 108 rocket launcher on the USS Wilkinson. In this new cable design, each single has a thin secondary insulation of clear ZYTEL 33, plus a tough outer armor of heat and light stabilized ZYTEL 37.

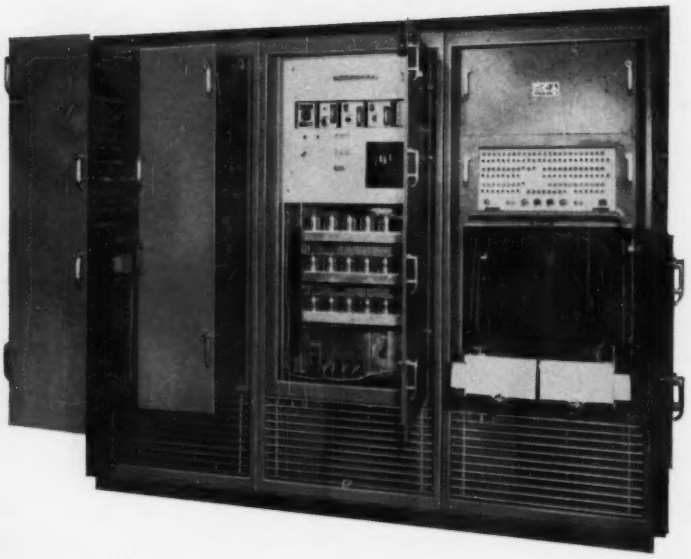
The two layers of ZYTEL are used for several important reasons. The armor protects the entire cable and allows it to be easily pulled through cableways without snagging or skinback. The two layers also provide outstanding resistance to cut-through, moisture and various hydraulic fluids to which the cable is exposed.

Because of the superior mechanical properties of ZYTEL, the jacketing is thinner than other materials could be, reducing the overall cable weight and diameter. The secondary insulation of ZYTEL 33 permits the effective use of watertight terminal lugs to prevent wicking. And its transparency allows easy reading of identification matter printed on the singles.

You may find that the use of ZYTEL nylon resins or other Du Pont wire and cable grade plastics can solve your problems. If you would like more information, consult your wire and cable supplier, or write to the Du Pont Company, Dept. EW-116, Room 2507Z, Nemours Bldg., Wilmington 98, Delaware.

ALATHON® POLYETHYLENE RESINS | **RULAN®** FLAME-RETARDANT PLASTICS | **ZYTEL®** NYLON RESINS

The only industrial computer with automatic priority analysis after each instruction . . .



RCA 110 ELECTRONIC INDUSTRIAL COMPUTER SYSTEM

Along with its "battleship" construction, ultra high-speed and maximum accuracy, the RCA 110 provides a critically important control function not available in any other industrial control computer . . . it automatically responds to off limit or emergency situations and handles them on a priority basis . . . *with a complete analysis of priority after each instruction!* This eliminates the delay between the occurrence and the recognition of an emergency condition.

Not only will the RCA 110 correct the most urgent situation first, but if more than one trouble-spot should occur at the same time, it *automatically* appraises the urgency of each and handles it in turn. Result—better control, programs are easier to write, memory space is conserved, and computer free time is automatically assigned to self-checking routines.

From its very concept the RCA 110 was designed not as a "package" but as a total system—which can be tailored to the exact data control needs of each user. In making your feasibility studies we invite comparison with all other electronic industrial computer systems.

For complete information write: Industrial Computer Systems Dept., Electronic Data Processing Division, RADIO CORPORATION OF AMERICA, 21 Strathmore Road, Natick, Mass.

COMPARE THESE PERFORMANCE SPECS

Speed—including access time and staticizing, adds in 56 microseconds, multiplies in 728, divides in 868. *Instructions*—one address (limited two address), 7 indexable address modifier registers, 71 wired-in instructions. *Number System*—fixed point, binary or binary coded decimal. 24 bit word length, word time 28.89 microseconds. *Working Storage*—magnetic core, coincident current, variable in size from 256 to 4096 words, 8 high-speed input-output registers, clock frequency 936 kilocycles. *Bulk Storage*—magnetic drum, 3600 rpm, 4096 to 51,200 words, 8.3 milliseconds average access time, 200 kilocycle transfer rate, up to 12 buffer tracks for input-output. *Size*—82″ high, 34″ deep, 105″ long. *Typical Power Input*—5 kva, 220 volts.

RCA®

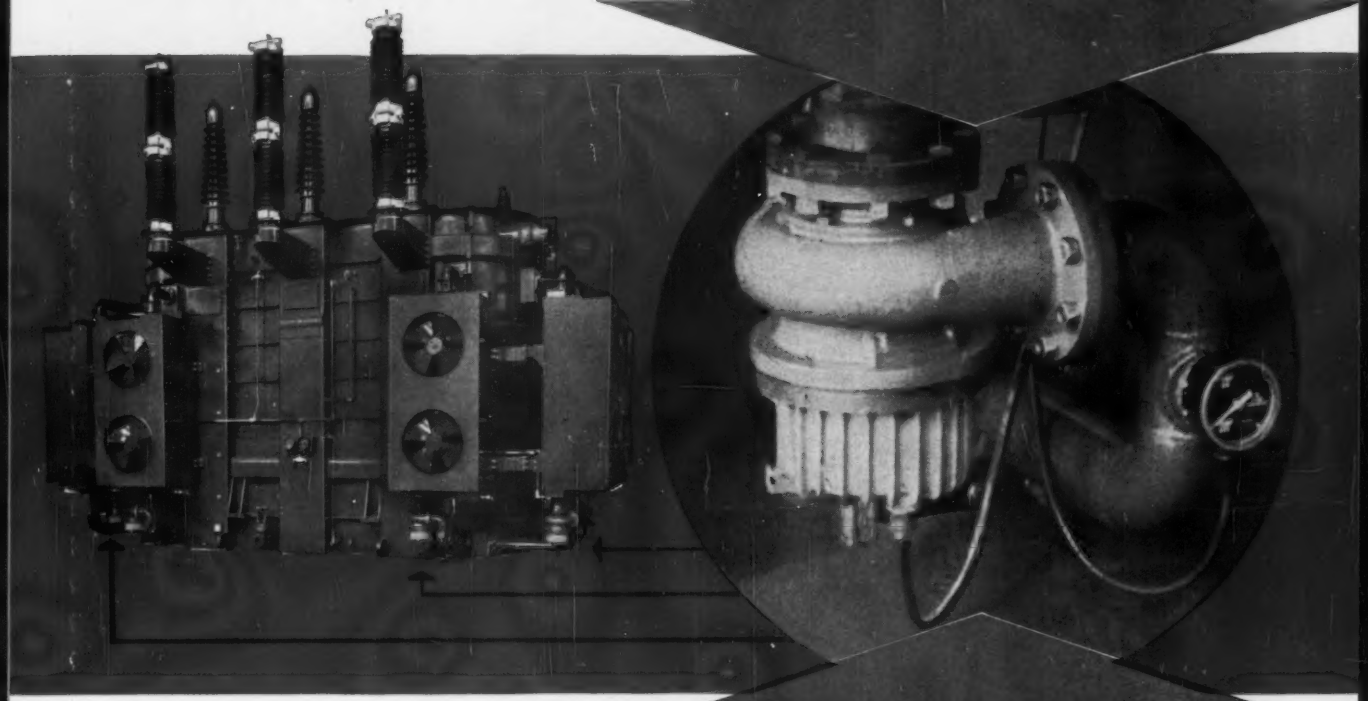
The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

...NEW... EXCLUSIVE... NEW... EXCLUSIVE... NEW... EXCLUSIV

ON MOLONEY FOA POWER TRANSFORMERS

A major improvement in FOA equipment is a new lightweight, self-contained, close-coupled pump. This new pump is one-third the weight of former models, thereby reducing total transformer weight. Fewer spare components are needed because this pump is interchangeable with any other pump of the same model. Maintenance is practically eliminated since the pump is self-lubricated and has a smaller gasketed area reducing the possibility of leaks. Installation and replacement of the pump



are facilitated by a power cord and plug attached to the motor.

The lower weight, reduced maintenance, and increased efficiency of this pump are a result of Moloney's continuous program of evaluating components to provide the best transformation at minimum operating cost.

Obtain lower operating cost and superior performance by specifying Moloney Power Transformers.

SELF-CONTAINED LIGHTWEIGHT OIL PUMPS

ME-60-23

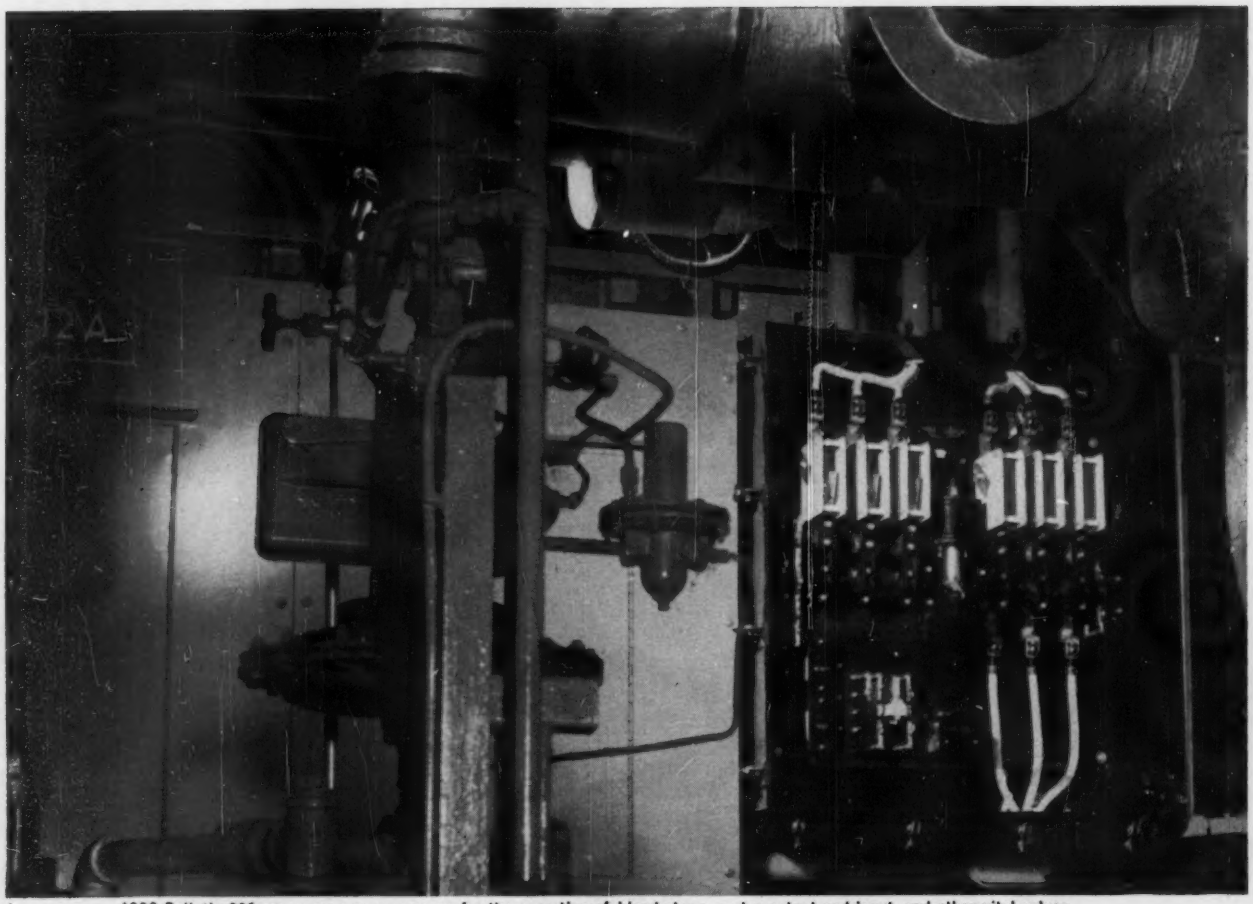
MOLONEY ELECTRIC COMPANY

Transformers for Utilities, Industry, and Electronic Applications

FACTORIES: ST. LOUIS 20, MO. AND TORONTO, ONT., CANADA

SALES OFFICES IN ALL PRINCIPAL CITIES

MOLONEY ELECTRIC ®



ASCO Bulletin 906 assures emergency power for the operation of bleed steam, water output and input, and other vital valves.

FOR ASSURED POWER

ASCO Automatic Transfer Switches Protect Key Equipment at Con Edison's Astoria Station

More than 50 ASCO Automatic Transfer Switches were specified by Con Edison for a variety of situations at its Astoria Generating Station, N. Y., where auxiliary power failure could not be tolerated. They protect generators, insure operation of key valves and control panels, stand ready at all times to transfer loads to alternate sources when normal power fails.

They must be dependable.

Dependability in an automatic transfer switch stems from several features. It must be designed for *continuous duty* in either normal or emergency position. The switch must be able to close safely on inrush currents 20 times full load rating so that contacts will not weld on tungsten lamp load.

Other features include *inherent* interlocking, precluding the possibility of both circuits being open or closed . . . *mechanical locking*, providing high contact pressure, minimum I^2R losses, and assuring that vibration or electromagnetic effects cannot open the con-

AUTOMATIC TRANSFER SWITCHES **SOLENOID VALVES** • ELECTROMAGNETIC CONTROL

CONTINUITY

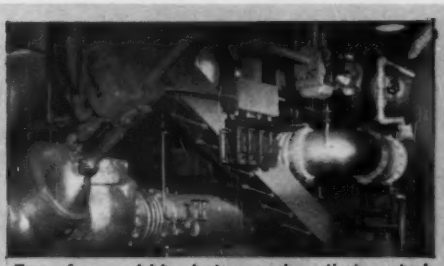
tacts . . . *single coil design*, providing construction simplicity, quiet operation . . . *built in time delay* so the equipment ignores harmless momentary outages.

Only ASCO Automatic Transfer Switches satisfy all these essentials in addition to the nominal requirements of transfer switches. For this convincing reason, many engineers are today specifying ASCO — *the one source for a full line of absolutely dependable automatic transfer switches.*

WRITE NOW FOR **CATALOG 57-SR1** DESCRIBING HOW TO SELECT AN ADEQUATE AUTOMATIC TRANSFER SWITCH.

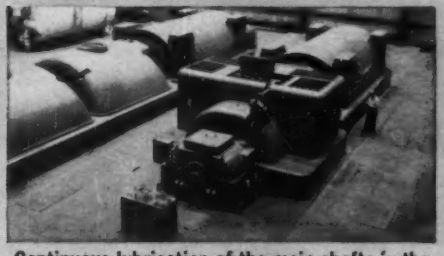
ASCO Electromagnetic Control

Automatic Switch Co. 50-P HANOVER ROAD: FLORHAM PARK, NEW JERSEY, FRONTIER 7-4600



Two of several bleed steam valves that control the flow of steam from turbines to the main condensers.

Power source for the operation of instruments on the control panel must not fail. Several ASCO units are used here.



Continuous lubrication of the main shafts in the turbo-generators is assured by auxiliary pumps shown in the photo below. The power for this equipment is assured by an ASCO Automatic Transfer Switch.

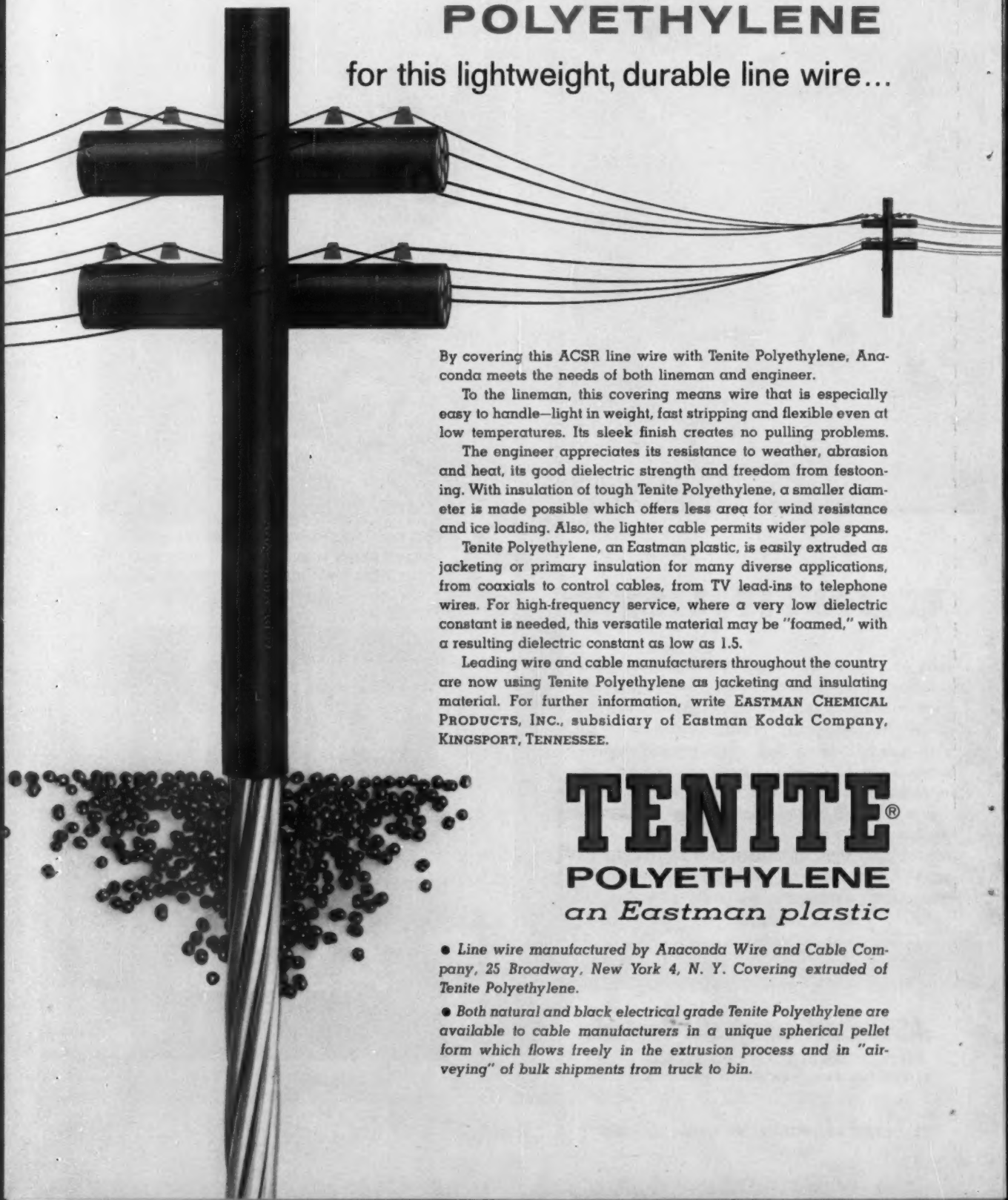
Inspector checks the oil level in the auxiliary lubricant pump for the generators.

ASCO®

ANACONDA uses covering of

TENITE POLYETHYLENE

for this lightweight, durable line wire...



By covering this ACSR line wire with Tenite Polyethylene, Anaconda meets the needs of both lineman and engineer.

To the lineman, this covering means wire that is especially easy to handle—light in weight, fast stripping and flexible even at low temperatures. Its sleek finish creates no pulling problems.

The engineer appreciates its resistance to weather, abrasion and heat, its good dielectric strength and freedom from festooning. With insulation of tough Tenite Polyethylene, a smaller diameter is made possible which offers less area for wind resistance and ice loading. Also, the lighter cable permits wider pole spans.

Tenite Polyethylene, an Eastman plastic, is easily extruded as jacketing or primary insulation for many diverse applications, from coaxials to control cables, from TV lead-ins to telephone wires. For high-frequency service, where a very low dielectric constant is needed, this versatile material may be "foamed," with a resulting dielectric constant as low as 1.5.

Leading wire and cable manufacturers throughout the country are now using Tenite Polyethylene as jacketing and insulating material. For further information, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE®

POLYETHYLENE

an Eastman plastic

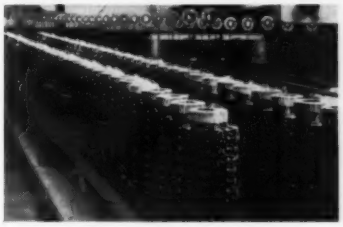
- *Line wire manufactured by Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y. Covering extruded of Tenite Polyethylene.*
- *Both natural and black electrical grade Tenite Polyethylene are available to cable manufacturers in a unique spherical pellet form which flows freely in the extrusion process and in "air-veying" of bulk shipments from truck to bin.*

Exclusive Lapp Process Stabilizes Power Factor and Loss in Post Insulators

A LAPP LABORATORY REPORT

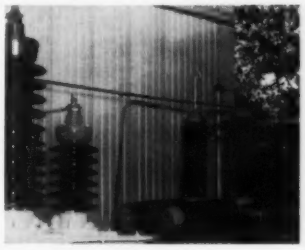
THE PROBLEM: Line Post and Station Post insulators occasionally have been found to show variation in power factor, charging current and watts loss under Doble tests. Field service seems not to have been impaired, but the phenomenon has been noticeable in such instances as erratic readings secured in tests of bushings connected to Post insulators.

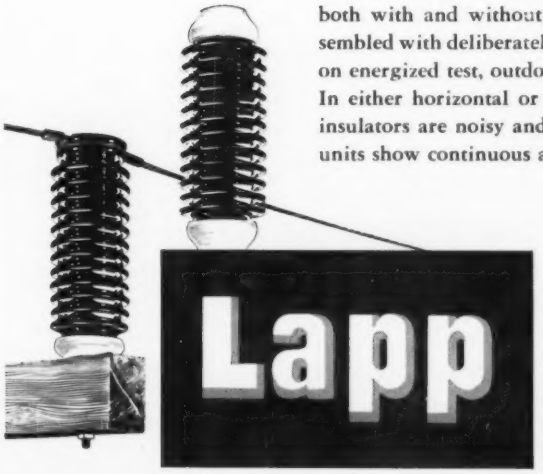
THE FINDING: Some years ago engineers of the Lapp Laboratory staff were assigned the job of tracing down the cause of such variations. It was located and identified as contamination deposits on the inside walls of the insulators. Porcelain bodies for Lapp Post insulators are subjected to a severe test for electrical soundness—a 3-minute flashover from the inside of the head around the body to the outside of the head. During this test the hole in the insulator fills with corona, and contaminating particles deposit on the walls of the hole; amount of this deposit and its effect on electrical characteristics vary with atmospheric conditions at the time of the test and at the time of plugging the hole for assembly.



THE SOLUTION: A thin coating of silicone applied to the wall of the insulator hole negates the effect of the corona contamination, and results in insulators dependably uniform in power factor, charging current and watts loss. Permanent effectiveness of the silicone coating is assured by its inherent chemical stability, and by the fact that the hole to which it is applied is sealed by the Lapp plug against weather, light, heat, or other physical or electrical attack. A Lapp patent is pending on the process.

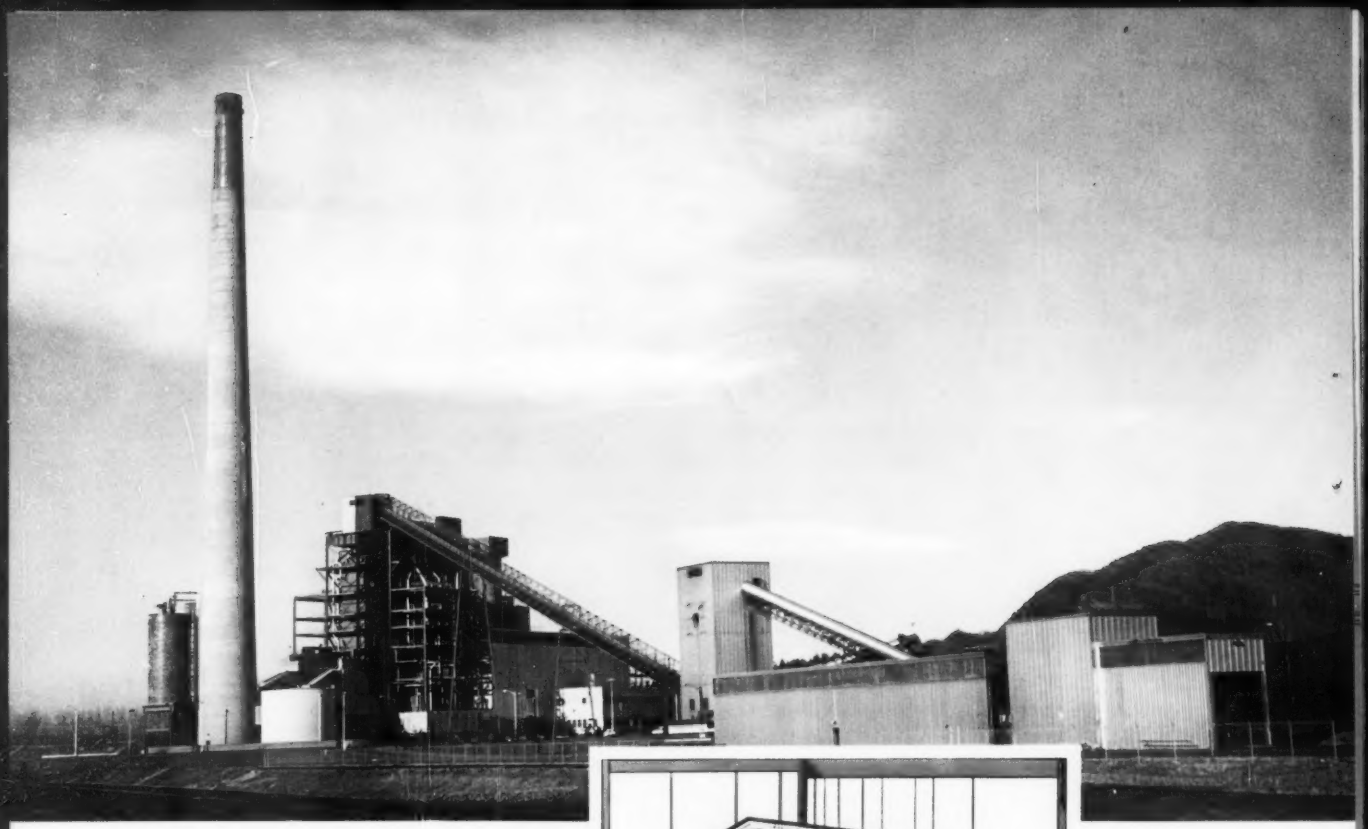
THE VERIFICATION: All Lapp Line Post and Station Post insulator production for more than three years has incorporated the silicone treatment. The low initial power factor of the insulator has been maintained on every unit re-tested after service. In addition, in an effort to determine limits of effectiveness of the process, a series of insulators has been set up in the Lapp laboratory. Post insulators, both with and without the silicone treatment, were assembled with deliberately-defective plugs. They have been on energized test, outdoors, continuously for three years. In either horizontal or vertical mounting, all untreated insulators are noisy and show high loss. Silicone-treated units show continuous and unchanging low loss.





THE CONCLUSION: To the widely-known advantages, in electrical and physical performance, of its Post insulators, Lapp research has added the characteristic of stability in power factor, charging current and watts loss. *At Lapp, insulator design and production is a matter of continuous development and improvement.*

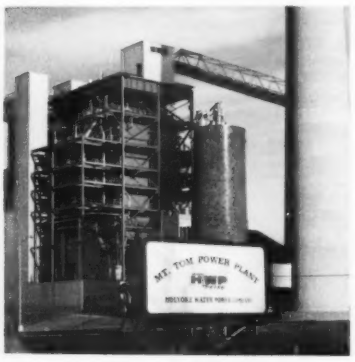
Lapp Insulator Co., Inc., Le Roy, N. Y.

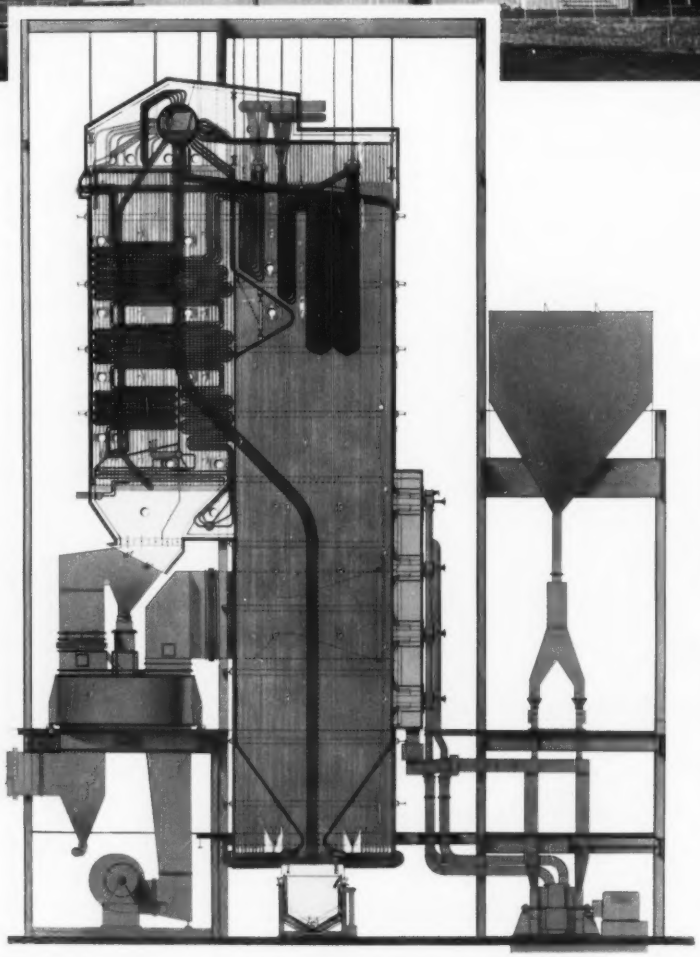


MOUNT TOM POWER PLANT

Holyoke Water Power Company

Mount Tom Power Plant, paradoxically located in a region rich in ancient geological formation and prehistoric lore, is a symbol of modern American engineering achievement. The Riley Boiler is one of the most northern boilers in New England featuring outdoor construction.





Mt. Tom Power Plant's Complete Riley Reheat Coal Fired Boiler
Steam Capacity — 950,000 lbs/hr
Superheat/Reheat Temp. — 1000/1000 F
Pressure at Boiler — 1950 psig
Fired by low grade strip mine coal pulverized in four Riley Duplex Pulverizers.
Sixteen Riley Burners.

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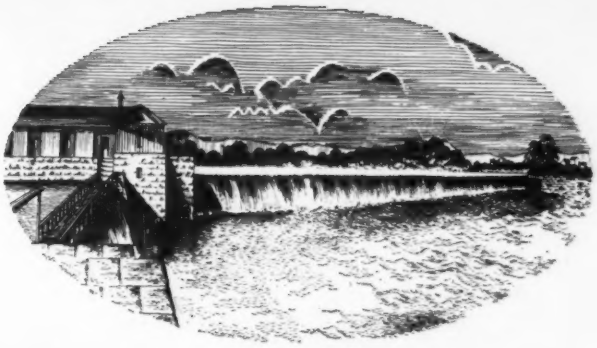

Holyoke Water Power Company Installs a 950,000 lb/hr RILEY Outdoor Type Reheat Boiler at Mt. Tom

Over a century ago Holyoke Water Power Company built a dam across the Connecticut River and a network of canals that provided power for the industries that made Holyoke, Massachusetts famous as a leading New England industrial center. Mt. Tom Power Plant located on a choice site for furthering industrial development can carry on this tradition for years to come. The new steam-electric plant with its capacity of 137,500 kilowatts brings Holyoke Water Power Company's total generation to 229,000 kilowatts. The Mt. Tom plant also supplements existing steam and hydro-electro facilities and provides a dependable source of power when hydro-electric power is reduced by insufficient river flow. Water for the 950,000 lb/hr Riley boiler comes from two never-failing wells at the plant site.

JACKSON & MORELAND, INC.
Consulting Engineers

Four Riley Pulverizers efficiently pulverize over 1300 tons of high ash content coal per day. A high degree of fineness is continuously maintained by long wearing tungsten carbide faced pulverizing elements. Operation is vibrationless and quiet. Flash drying feature permits use of unusually wet coal.

Riley offers a complete line of boilers from package unit sizes to the largest central station types. The Riley line of fuel burning equipment offers a wide selection for solving virtually any fuel burning problem. Before you make any decision on new facilities talk to your Riley Representative.

A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

RILEY

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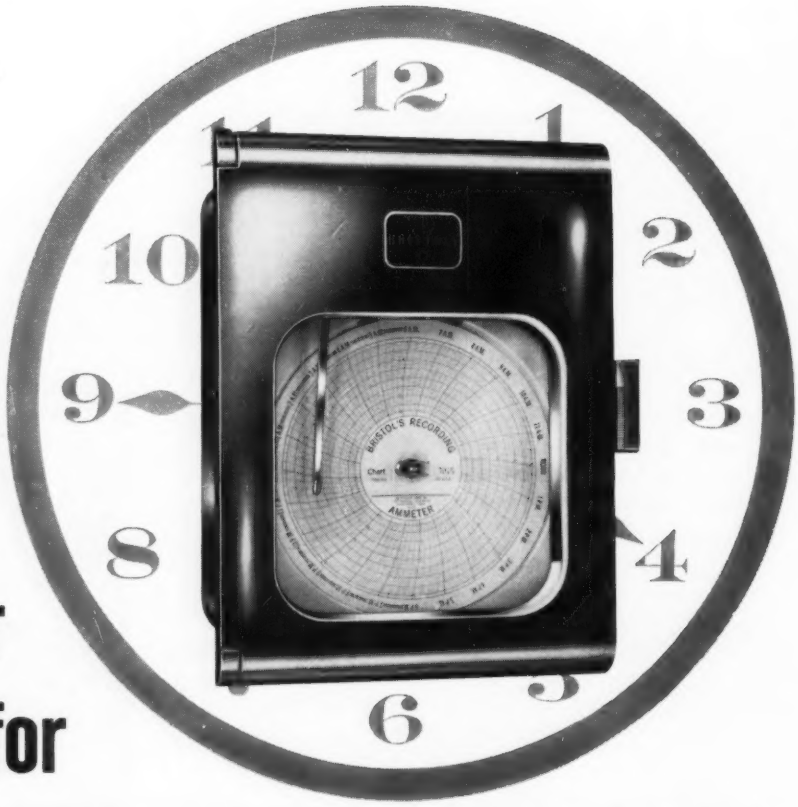

The recording ammeter for 'ROUND-THE-CLOCK RELIABILITY

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Bristol recording ammeters give you maximum accuracy and reliability under field conditions—all the time.

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one crimp per end!

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Position the OH25 once ... and only once ... on each side of the INSULINK or uninsulated LINKIT. It has a new die that crimps the entire contact area at one time. You don't have to reposition, you can't overlap crimps, and you never make less than the proper number of crimps.

And, it takes only ONE CRIMP PER END ... a series of easy, ratchet controlled strokes to make a perfect crimp every time. The new dies cause the conductor strands to rub together, removing the oxide film for more stable, low resistance connections.

Insert stripped wire ends into INSULINK; caps grip and hold conductors.

Get up close to your work. Position ONE-HAND TOOL on INSULINK only once per crimp.

A series of easy strokes complete the crimp. Dies produce oxide removing wiping action between conductor strands.

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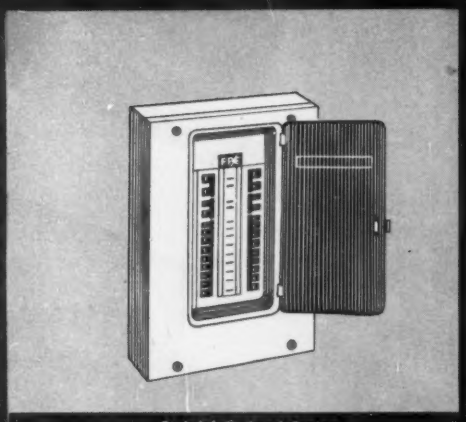
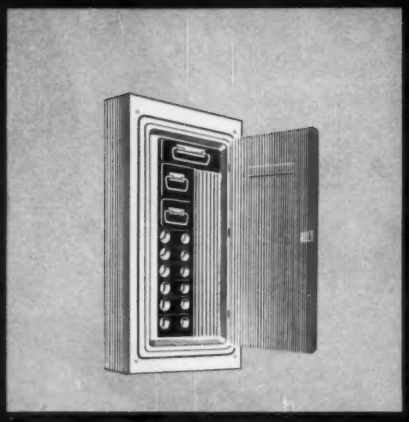
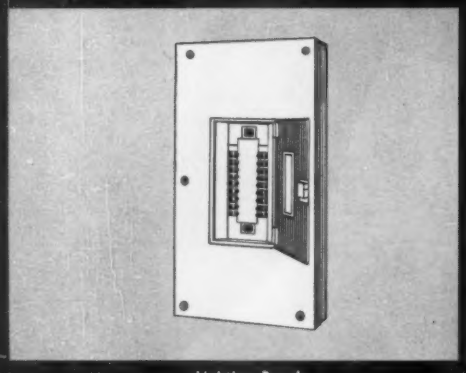


Stab-lok® Load Centers

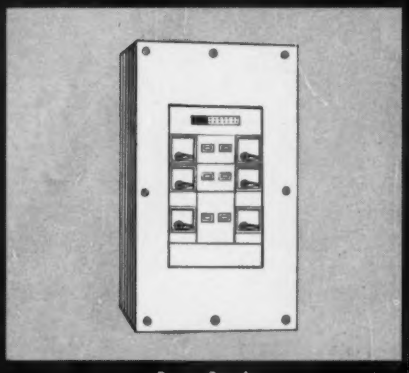


SF Fusible Load Centers

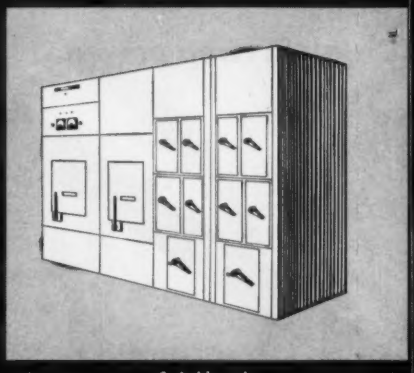
Safety Switches



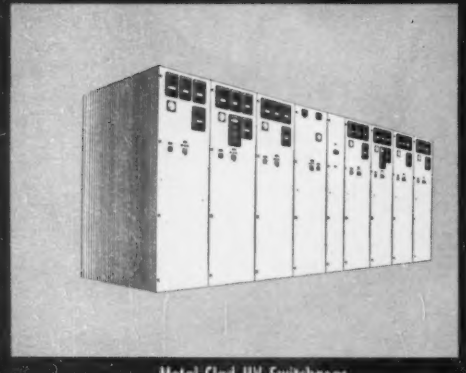
Lighting Panels



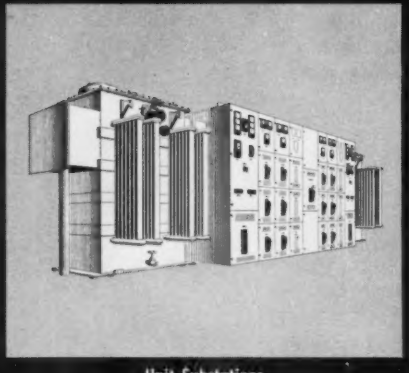
Power Panels



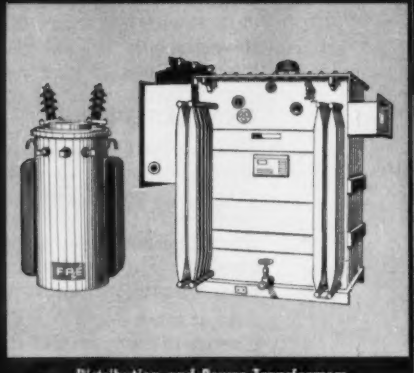
Switchboards



Metal-Clad HV Switchgear



Unit Substations



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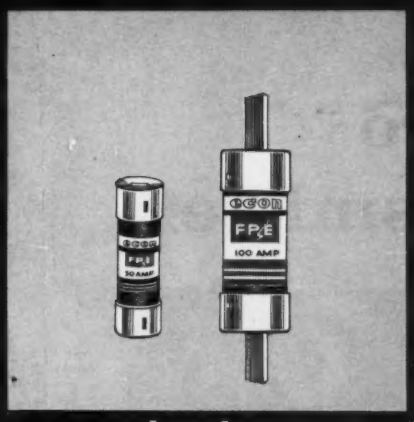
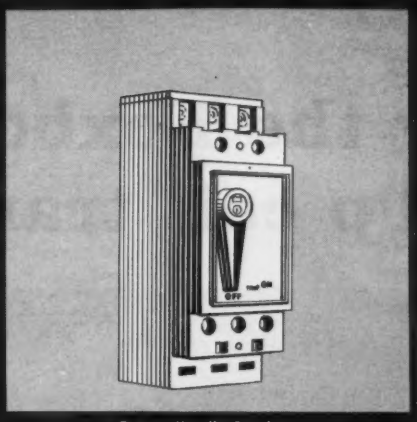
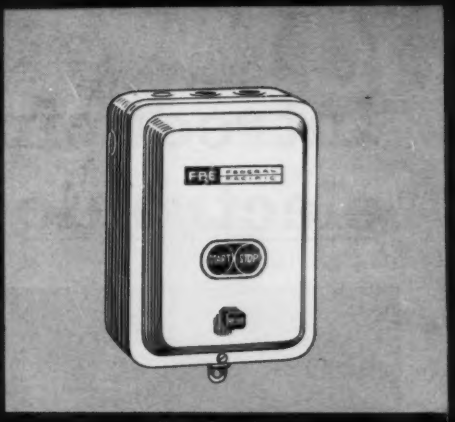


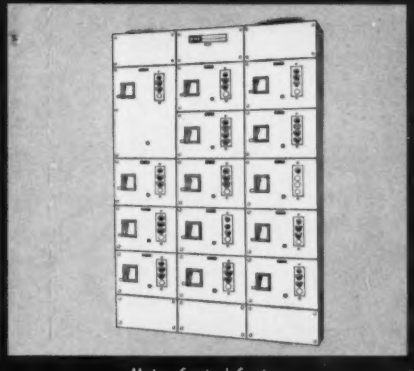
Economy Fuse



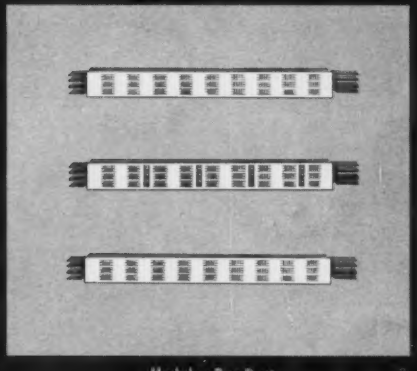
Rotary Handle Breakers



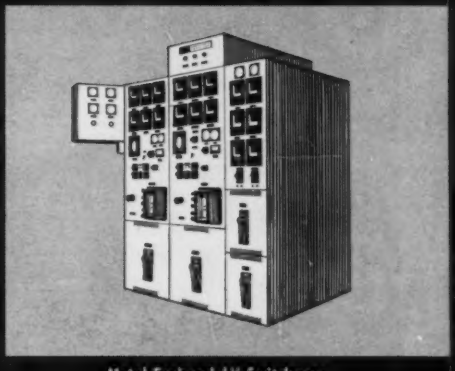
Motor Controls



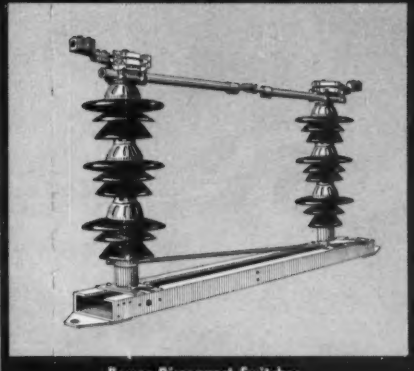
Motor Control Centers



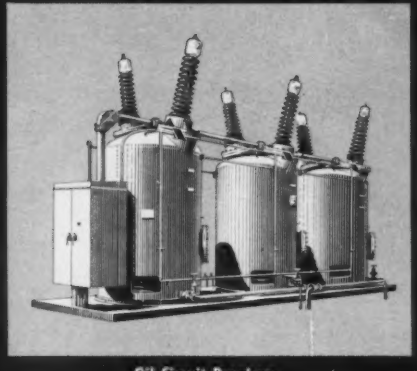
Modular Bus Duct



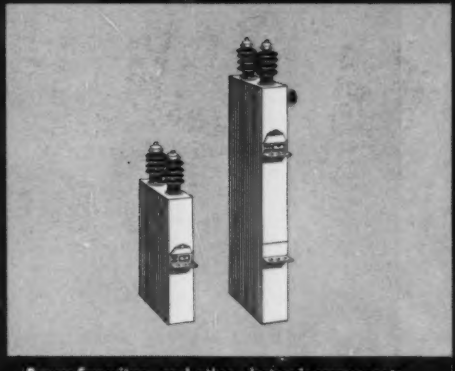
Metal-Enclosed LV Switchgear



Power Disconnect Switches



Oil Circuit Breakers



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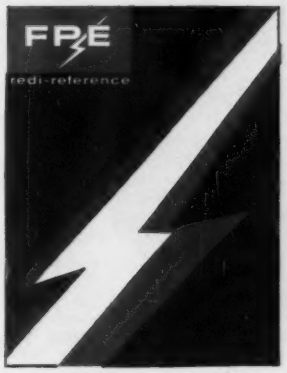

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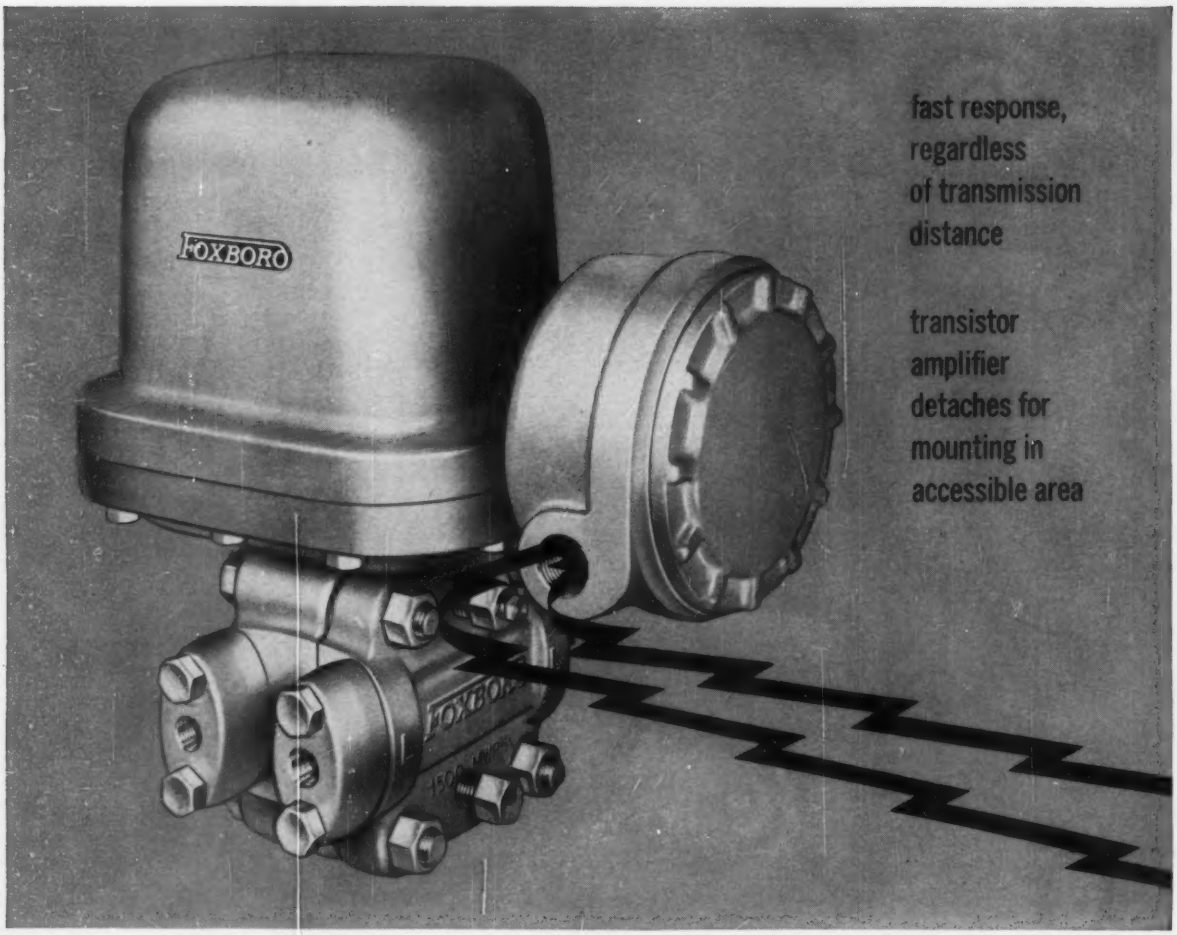
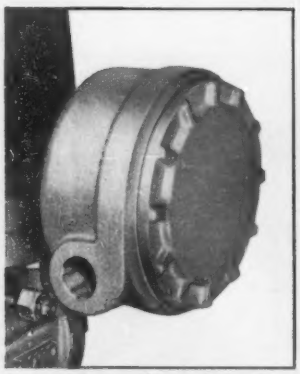

FOXBORO
fast response, regardless of transmission distance
transistor amplifier detaches for mounting in accessible area



Transistor amplifier of the Foxboro Electronic d/p Cell can be detached for relocation in an accessible area, so that all transistors are removed from possible contamination. Separate mounting has absolutely no effect on accurate measurement and transmission.

Yes, Foxboro has taken its famous pneumatic d/p cell transmitter and added to it the benefits of electronic transmission. Look at the results:

- true force-balance design for lowest displacement — fastest response
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- same body, same performance as thousands of pneumatic d/p cells now in operation
- ranges from 5 to 850" of water — maximum working pressures to 6000 psi

And then, of course, you get the same positive overrange protection, the same high sustained accuracy, the same rugged construction that has always been standard with the Foxboro d/p cell transmitter.

Foxboro electronic d/p Cells are presently in use measuring and transmitting: pressurizer level, primary coolant flow, and steam generator 3-element feed-water level and flow. For full details on this important unit in the Foxboro Electronic Consotrol* family, get in touch with your Foxboro Field Engineer. Or write for Bulletin 21-10. The Foxboro Company 241 Norfolk Street, Foxboro, Mass.

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G&W

High Voltage

POTHEADS

offer simplified design; lower cost

Simplification of G&W's original Type AT pothead design has resulted in lowering costs of the new high voltage pothead line, ATA-N and ATL-N. The outstanding mechanical and electrical characteristics which have been responsible for the fine performance of the original Type AT potheads have been retained. Maximum interchangeability of parts is one of the advantages gained by the simplified design. Also, the use of a straight-through type ferrule provides a more stable connection to the overhead line.

A new means of retaining gaskets is a definite improvement in sealing against high pressure. Successful tests up to 750 psig of hydrostatic pressure indicate that these improved G&W Potheads have superior performance characteristics under operating static heads in excess of 200 psig (nominal).

Type ATA-N and ATL-N potheads are another example of the constant improvement being made in G&W products. Their performance and dependability is based upon G&W's thorough understanding of electrical and mechanical requirements for cable accessories gained from 55 years of engineering development, testing, and operating experience. Consult with a G&W Representative on your present and future cable termination needs, or write us for full information.

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AT60-1

Here are answers to some about KPF switches

Q. *How can KPF switch blades maintain positive contact with switch clip under changing line sag conditions?*

A. Two heavy copper clips, bolted to a shoe carrying the flexible jumper, are mounted inside a special "horseshoe shaped" casting by two toggle bolts. These toggle bolts pass freely through the outer leaves of the clips, and the entire contact assembly "floats" on these bolts. Half-spherical bolt heads and adjusting nuts permit movement in any direction. The tension of the clip leaves on the blade is sufficient to insure positive alignment, since either clip or blade can follow the other to conform to line sag changes.

Q. *How can insulator stacks follow normal line sag changes?*

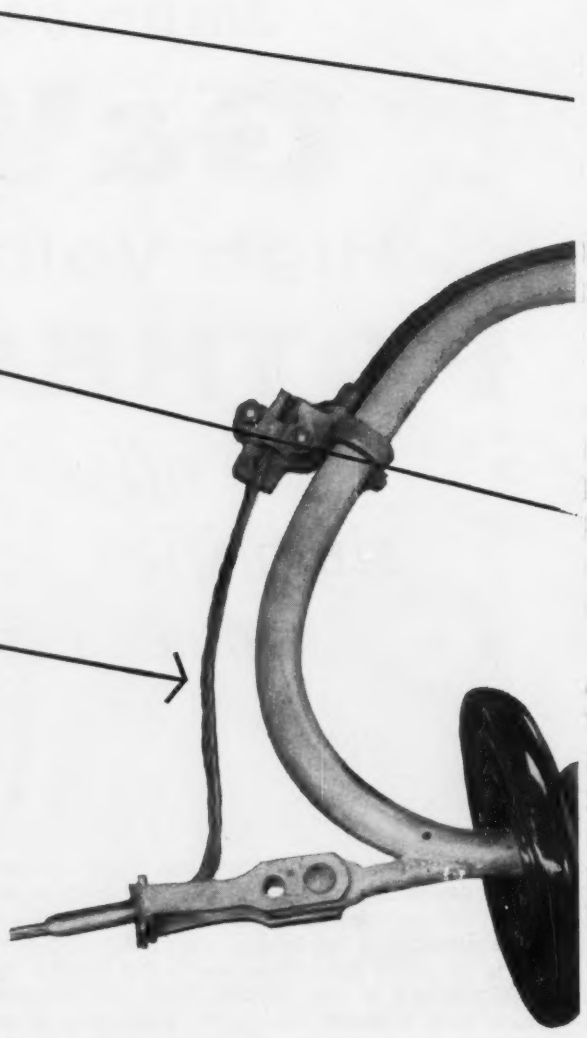
A. The insulator stack bearing units may be likened to limited universal joints. The actual bearing, a monel pin in an everdur trunnion, allows 90° movement of the rotating arm of the phase unit, as well as approximately 7° vertical movement to follow line sag. It is impossible for the bearing to bind under normal line stress, and insulator stacks always follow the sag of the conductor.

Q. *How are conductors connected to KPF switches?*

A. With KPF Type A switches, the user eliminates dead-end insulators. Any standard strain clamp can be used, and hot lines may be dead-ended directly to the phase units. Switch arms and dead-end eyes are integral with the insulator assembly. The conductor is lead through the strain clamp and on to a copper terminal on the switch arm. Aluminum conductors may be connected to the switch arm through special KPF terminals designed for this service. Type A switches may be mounted on a separate crossarm with conductors deadened below or above (for angle-pole installations, etc.). Switch operates equally well with or without line tension.

Q. *For what voltages are KPF air break switches available?*

A. KPF Type A and S standard "line-tension" switches are available for common voltages from 7.5 to 110 KV. Special switches combining a disconnect with a fuseholder (Type UF, double-cross-arm mounting) and for use where line tension is not present are also offered in these same voltage ranges. Ground switches are available for Type A or S switches. Type R switches are offered for use where line tension is not present or it is desired to use a specific type of apparatus insulator.



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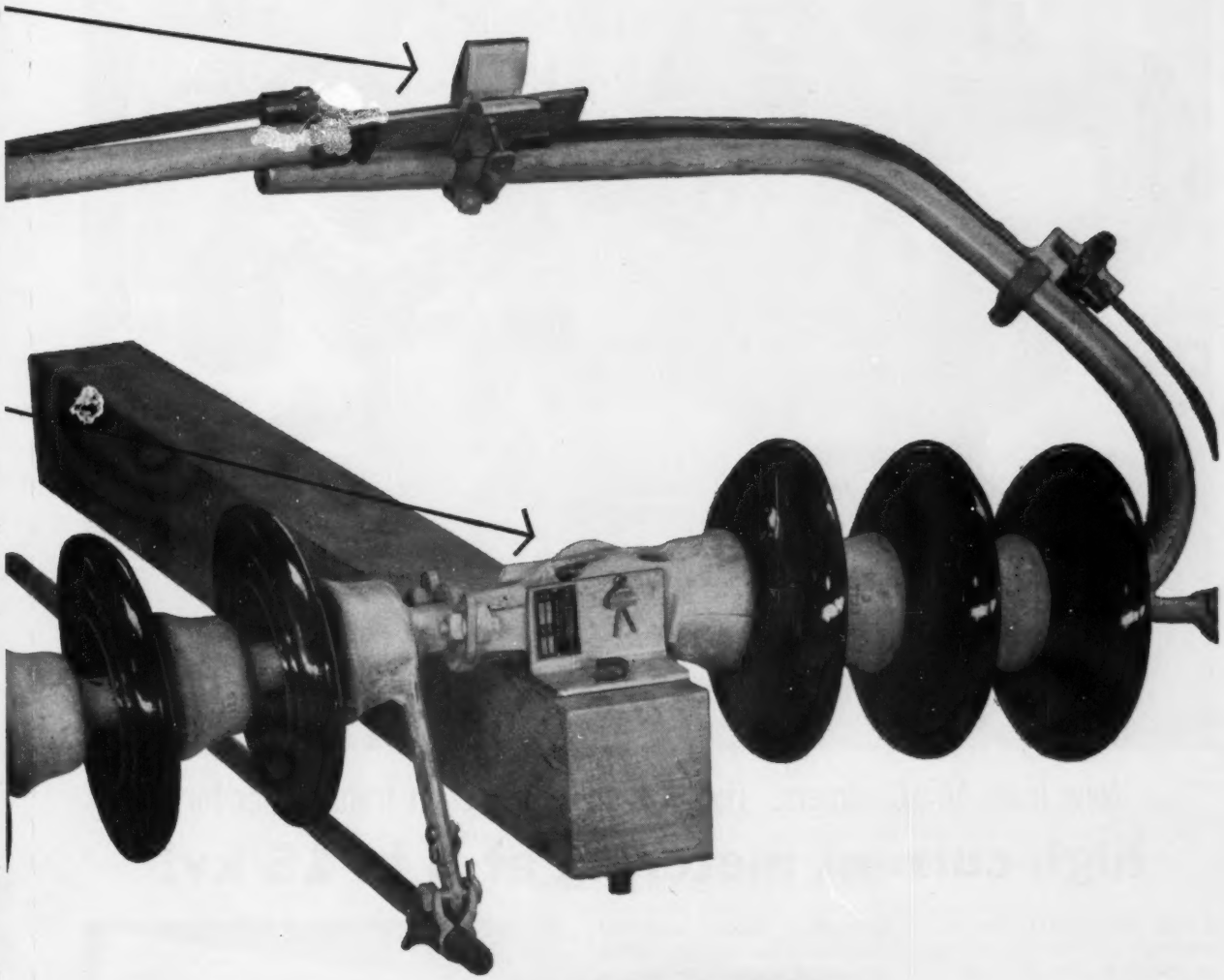

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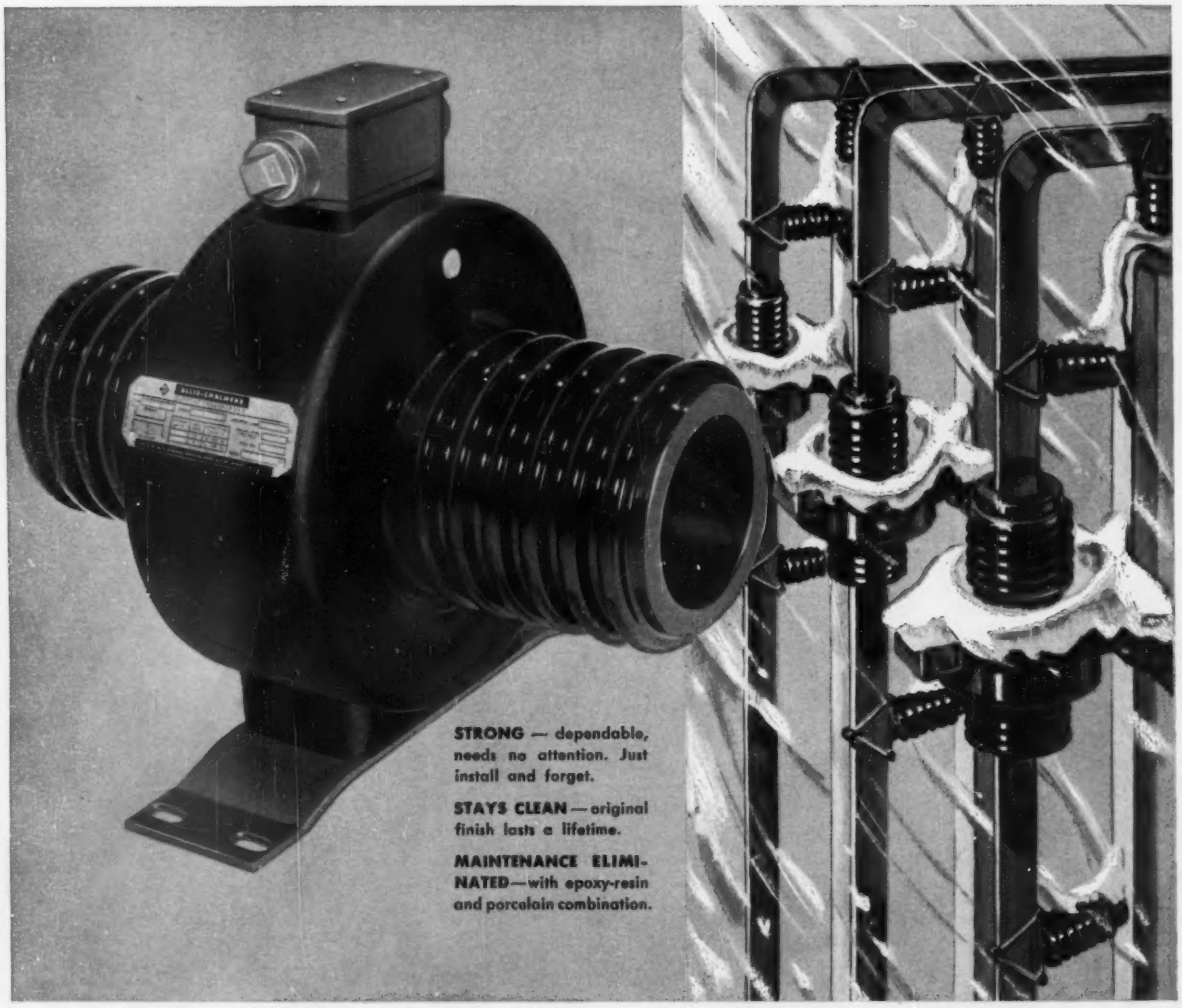
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Editorial Comment

JANUARY 16, 1961

The Breed Plant Story: A Study in Significance

In this issue, *Electrical World* presents the Breed Plant story—the saga of a highly significant steam-electric station.

Rarely has this magazine devoted so much space to one subject. That we do so here shows our deep belief in its significance.

What is this significance?

For some, it will be, simply, the advent of a huge, highly efficient generating unit. For others, it will be the audacious melding of the best available, *proven* concepts of generation, transmission, and plant siting, to provide an outstanding record of cost minimization where it counts—at the load center buses.

Yet, to us, the significance drives much deeper.

Breed has shown, with clarity and force, what several segments of American business are capable of achieving, in concert, when their leaders unleash a truly pioneering spirit.

For insight into why Breed's example is so pertinent *right now*, one has only to examine today's crosscurrents of events.

- Two nations are in mortal struggle for superiority in military might—and economic prowess.
- There has been a midstream change in American national leadership. Especially in view of the international conflict, this change has the *potential* of upsetting that very business system which can produce such achievements as Breed.
- Our national economy is not growing fast enough to suit the requirements of the perilous age. And this slowness has the *potential* of providing a plausible excuse for those who, under the new Administration, might like to change the system.

In this framework, the ability to point to a prime example of our business system's intrinsic ability to pioneer, especially in such a highly capitalized area, is vital. Breed certainly provides such an example.

In the first article of the Breed Plant story, starting on page 47, is given the fascinating background for the evolution in technology underlying all the major engineering decisions. From this article can be sensed the teamwork between utility and manufacturers which made the whole thing a reality.

But Breed Plant itself is but a fleeting milepost of technical and economic accomplishment. Its roots run deep, through frontiering names like Tidd, Tanners Creek, Sporn, Kanawha River, Muskingum River, Clinch River, Kammer, Philo, Deepwater and Twin Branch. But the powerful momentum of the efforts which evolved Breed from these antecedents must not be halted.

And it cannot be halted as long as the underlying pioneering spirit and leadership provided by Philip Sporn and his collaborators remain unfettered.

We believe that there is danger that fetters may be applied, possibly by gross manipulation of the basic economic system. Certainly, we do not know, at this stage, how real (or imagined) the danger is. But the *potential* is there.

The Breed Plant story provides a powerful argument for the premise that the American business system, as imperfect as it is, has provided *and can continue to provide* the dynamic drive so mandatory at this hour.

Choice Narrows on Interior Jobs

Co-op man may head Water and Power Development section. California water official seen as Undersecretary

Two Kennedy appointments for the Interior Department and one holdover from the existing administration were moving from the rumor stage to the sure thing category as *Electrical World* went to press. According to insiders, James K. Carr, Chairman of the California Water Commission is slated to be Undersecretary of the Interior; and Ken Holum, general manager of the Mid-West Electric Consumers Assn, a preference group in the Missouri Basin, is headed for the post of Assistant Secretary—Water and Power Development. Floyd E. Dominy is reported to be sure of retaining his present post as Comissioner of Reclamation.

Another rumored appointment that appears to be firming up is that of John Carver, now administrative assistant to Sen Frank Church (D-Ida.), as Assistant Secretary—Public Land Management.

Last summer, Holum's group filed with US Bureau of Reclamation a proposal for federal and non-profit construction of a 345-kv transmission network, several large steam plants, and eventually, a 500-kv tie with the Bonneville Power Administration. The group includes cooperatives and municipals in the Upper Missouri Valley (EW, Aug. 8, 1960, pp 28-29).

However, the shift in political administrations will produce a relatively small change of faces in most other federal power-related agencies in Washington.

This is because: (1) The incoming Kennedy administration apparently is satisfied with many of the Eisenhower appointees; (2) Office tenures and job-holding regulations further limit the number of posts which Kennedy can fill.

Politics, precedent and peculiar circumstances, however, still cloud the fate of several key posts.

Democrats to Control AEC

Briefly, President-elect Kennedy will get Democratic control of the Atomic Energy Commission immediately, and control of the Federal Power Commission and Securities & Exchange Commission in June. No change is expected at the Rural Electrification Administration, Bureau of Reclamation or Corps of Engineers. The changeover in top departmental posts, however, should cause policy shifts at both REA and the Bureau of Reclamation, as well as the Administrators of Bonneville, Southeastern and Southwestern Power Administrations. The "non-political" Tennessee Valley Authority won't have a vacancy available in its three-man directorate until 1963.

Here's a run-down of federal commissions and agencies which are responsible for regulation and operation of electric power facilities:

• Federal Power Commission (presently, three Republicans, one recess Democratic appointment, one vacancy) — John F. Kennedy may get a Democratic majority on the five-man FPC in June, when the term of GOP member Arthur Kline expires. The existing vacancy can be filled immediately. This, with the recess appointment of Democrat Paul A. Sweeney, would give Kennedy a 3-2 majority in June, whether Sweeney is confirmed by the Senate or whether his recess appointment is allowed to expire in December.

Sweeney is serving in a recess appointment, but is filling the post of a regular commissioner whose term would expire in 1963. Thus President-elect Kennedy could reappoint Sweeney, a government career official. Or Kennedy could choose someone else for the post. In such a case the new man would take over the job just as soon as he had received the approval of the Senate.

The other two FPC posts are held by Republicans: Chairman Jerome K. Kuykendall and Commissioner Fred Stueck. Kuykendall is legally entitled to hold his chairmanship of the FPC until the termination of his appointment in June, 1962. But there has been speculation that he

DOMINY: Holdover?

HOLUM: Water & Power?

CARR: Undersecretary?

might not want to remain as a minority chairman, and might step down as chairman in exchange for assurance that he would receive another appointment as commissioner when his term expires next year. Stueck's term expires in 1964.

No other presidential appointments are open at the FPC, although General Counsel John Mason and Executive Director Harry Trainer are "class C" jobs—meaning that a majority of the commissioners could vote to remove them. This isn't likely.

• Securities & Exchange Commission (three Republicans, one Democrat, one vacancy)—John F. Kennedy, again, can get a Democratic majority on the SEC in June, when the term of Republican Daniel J. McCauley Jr expires. Kennedy will fill the existing SEC vacancy immediately, and this, with Democratic Commissioner Earl Freeman Hastings and the McCauley replacement, will give the SEC a 3-2 Democratic majority.

SEC Chairman Edward N. Gadsby could hold his chairmanship to the end of his term, as in the case of Kuykendall, but he will be a minority chairman after June. Gadsby's term expires in June, 1963. The other SEC commissioner, Republican Byron D. Woodside, holds office till June, 1962.

• Atomic Energy Commission (two Republicans, one Democrat, two vacancies)—John F. Kennedy will have an immediate opportunity to get a Democratic majority on the AEC when he nominates men to fill the two vacancies. One of these vacancies will be for AEC chairman, and the other calls for a scientific member of the Commission. The post for scientific member expires in June of this year, so Kennedy may make his new appointment for the short term, and then reappoint the same man for the full term.

Republican AEC Commissioners Robert E. Wilson and Loren K. Olson hold office till June of 1965 and 1962, respectively; Democratic Commissioner Hastings holds office till June, 1964.

• Rural Electrification Administration—REA Administrator David A. Hamil is starting the fifth year of his ten year appointment, but he calls himself a "political realist," and would resign if asked to.

Rash of Old Power Bills Get New Try in Congress

A new Congress (the 87th) has convened in Washington, and with it has come a rash of new legislative proposals affecting the electric power industry. Most of the bills are identical, or similar to ones introduced in previous years.

Burns Creek—Legislation to authorize a federal, $50-million, 90-Mw Burns Creek Dam on the Snake River, Ida., as part of the Palisades Reclamation project, was introduced in the Senate (S-66) by Sens Frank Church (D-Ida.) and Henry Dworshak (R-Ida.); and in the House (HR 36, HR 378) by Reps Gracie Pfost (D-Ida.) and Ralph Harding (D-Ida.). Bills were referred to the respective Interior Committees.

Recreational Benefits—Bills were introduced in the Senate (S-121) by Sen Robert Kerr (D-Okla.) and in the House (HR-1834) by Rep James Trimble (D-Ark.) to authorize consideration of recreational benefits at federal public works projects, when determining multipurpose cost allocations; referred to the respective Interior committees.

Capital Budgets—Bills were introduced in the Senate (S-195) by Sen Wayne Morse (D-Ore.) and in the House (HR-960 and HR-1968) by Reps Edith Green (D-Ore.) and Al Ullman (D-Ore.) respectively, to distinguish between federal expenditures for capital investment and operating costs. Bills were referred to the Senate and House Government Operations Committees.

Resources Council—Sen Clair Engle (D-Calif.) has introduced a bill (S-239), similar to legislation (S-2549) last year, to create a federal resources policy, and to create a permanent Federal Council of Resources and Conservation Advisors; referred to Interior Committee.

Fryingpan-Arkansas—Sens Gordon Allott (R-Colo.) and John Carroll (D-Colo.) have introduced a bill (S-284) to authorize the federal multipurpose Fryingpan-Arkansas water diversion project across the Continental Divide in Colorado.

Regulatory Agencies—Rep Oren Harris (D-Ark.) has introduced a "cleaned up" bill (HR-14) identical to the final committee version of last year's HR-12371; and Rep Dante Fascell (D-Fla.) has introduced a similar bill (HR-349); both referred to the House Commerce Committee.

REA Interest Rates—Rep Edgar Hiestand (R-Calif.) has again introduced legislation (HR-968) to raise REA interest rates to the going cost of borrowing the money by the US Treasury; referred to the House Agriculture Committee.

Depressed Areas — Sen Paul Douglas (D-Ill.) and 44 other senators have introduced a bill (S-1) to authorize spending of federal funds in the "depressed area" covering mountainous parts of 11 eastern states, including public works projects—implementing President-elect Kennedy's depressed area task force report. An identical bill (HR-361) was introduced in the house by Rep Kenneth Gray (D-Ill.); legislation was referred to respective Banking & Currency Committees. Less drastic bills were introduced in the Senate (S-6, S-9) by Sens Hugh Scott (R-Pa.) and Everett Dirksen (R-Ill.), and in the House (HR-1084) by Rep John Saylor (R-Pa.).

Trimble Bill—This bill (again HR-8) was re-introduced by Rep James Trimble (D-Ark.) to revise allocation of costs at federal multipurpose projects, reducing the cost of power, extending amortization periods, in some cases up to 100 years. It is identical to his 1958 bill.

Boggs Bill—This bill, so far, has been introduced (HR-45) by Rep Olin Teague (D-Tex.), and referred to the House Ways & Means Committee, to permit the deduction of contributions to "lawful legislative purposes" from federal income taxes. It's similar to last year's HR-7123, introduced then by Rep Hale Boggs (D-La.).

Anticipated legislation may be introduced soon on the following subjects: **(1)** A bill to create a federal, "valley-type" power marketing agency in the Bonneville Power Administration area of the Pacific Northwest, probably by Sen Maurine Neuberger (D-Ore.); **(2)** Legislation to extend federal reclamation laws to 50 states, probably by Sen Clair Engle (D-Calif.).

This Month in Europe . . .

Chandos Cites Need for More Mergers

J. H. M. SYKES, Overseas Engineering Correspondent, London

J. H. M. Sykes: You have said long-term financing of overseas contracts, particularly in the underdeveloped countries, is one of the greatest difficulties facing the heavy electrical industry. Do you feel Britain can ultimately hold her own in this area?

Lord Chandos: Not in free competition, obviously. There are countries whose balance of payments position will enable them to give longer term credits than we could. But of course there are things like the Berne Union, with which we all agree, which limits the length of the credit; but nevertheless there are institutions outside the Berne Union which give very much longer credits than we are able to. . . . We do lose business . . . because our foreign competitors open longer-term credits. . . . Recent measures to provide better terms for export credit taken over here are about as far as you could expect the British government to go, and I think they are going to be a distinct help.

Sykes: Is government aid a solution?

Chandos: Oh no, not a solution, no. It's a help of course, but first of all you've got to have the right prices. The length of the credit is sometimes governed by perfectly sound economic facts. If you take a power station . . . from the moment the order is placed until the time it's going to earn profits . . . may well be seven years. And it isn't an unreasonable thing to try and get seven years' credit in order to get the power station . . . earning revenue before you've got to pay back the bulk of the money invested in it. Quite apart from the competition, the fact that you could open seven-year credits does increase the area in which export business could be done. It doesn't guarantee that it's coming here, but it widens the outlook.

Sykes: The . . . rise of British exports has not been as steep as in the years since the war. I think it was only 2% increase last year. Has a factor in this been the question of the extension of long term credits?

Chandos: Yes, undoubtedly it has.

Sykes: Would you favor any government intervention in this matter?

Chandos: Well, there is government intervention in the sense that you can insure your exports with the Export Credit Guarantee Department [government insurance against nonpayment by the purchaser].

Sykes: But is that as positive intervention as in some countries?

Chandos: Maybe not, but I would be against the tax alleviations for the exporter. . . . I think it tends to distort the whole pattern of trade and it leads to an undesirable form of competition. . . .

Sykes: It becomes government against government?

Chandos: Yes. . . . There are countries in which the depreciation allowances for new manufacturing plant are extremely lenient . . . and—I'm just throwing this off, I haven't thought it out—you might be allowed some slightly quicker depreciation of your plant in the proportion that the products of that plant are exported. . . . [This would not] throw up quite so many difficulties as direct tax incentive [which] is extremely difficult to administer. . . . With indirect exports—the electrical components that are contained in other machines and so on—you're getting into a fairly difficult area. But . . . if 30% of the products of a particular plant can be shown as being exported, directly or indirectly . . . you might get a quicker rate of depreciation as regards 30% of the plant investment.

Sykes: That raises this question of the enormous R&D effort the large manufacturers have to put in. I think Britain is at least level with anyone else—certainly in nuclear stations, larger generating units, or railway electrification. Can that leadership be retained in view of the increasing research and development effort needed?

Chandos: Leadership, I think, is a very dangerous word. . . . One moment you're ahead on a graphite-moderated reactor; the next moment the Americans are developing reactors with enriched-fuel or boiling-water reactors. I'm rather allergic to the term leadership. . . .

Sykes: Well, level with the leaders . . .

Chandos: . . . It's not all a question of money. I . . . remember a remark of Sir Ben Lockspeiser's [chief adviser to the government on scientific research] when he gave up his job. He said, "I don't think, looking

Chandos Has Long Experience in Industry, Government

Chairman of Associated Electrical Industries Ltd, Britain's largest electrical manufacturer, since 1954, Lord Chandos has been a leader in government and industry for many years. In Churchill's wartime cabinet, he was Minister of Production, and, earlier, Minister of State. He is also a director of Imperial Chemicals Ltd, and president of the Institute of Directors.

in Britain

back on my life as a scientist, that I would've asked for more money." Now what he meant . . . was that the absence of unlimited resources does produce an eclectic or selective effect on discovery and research and development. You can't go down several roads at once—you put the scientists and the development engineers onto the problem of what is the most likely one. . . . It's remarkable that some of the American industries regard the European scientists as more ingenious because Americans have established on the continent of Europe establishments engaged in "blue sky" research, and these are to be entirely peopled by European scientists. . . . I think inventiveness is stimulated by the relative shortage of funds. We all know that . . . having to "make do" does produce an eclectic attitude of mind which rejects certain courses as being unlikely to come to a result. But there are aspects where we in Britain could criticize ourselves. There is not, in my opinion, nearly enough cooperation between the large electrical groups on fundamental research. . . . We do waste a great deal of our technical manpower. Is it really sensible that you should have five teams on producing a tender for one reactor?

Sykes: At a cost of £200,000 each tender, I think you once said? [British pound (£) equals $2.80]

Chandos: Yes. The government . . . has recognized that cost by saying it is going to pay £ 100,000 to the unsuccessful tenderers. But it doesn't really get to the root of the problem. . . . There are too many teams chasing too little business, chasing too few discoveries, and therefore, in the nuclear field the competition is now largely telescoped; and that kind of thing on the more fundamental types of research—stopping short of development—I think is very desirable.

Sykes: You said recently there was need for more coalescing of the manufacturing industry . . . In the light of the most recent developments in Britain is it still necessary?

Chandos: Oh, I'm sure that it is necessary. There is the certainty, in my opinion, of these groupings taking place in the Common Market. . . . We've got to match that trend, I think, by larger combinations. . . . It's the larger corporations that can afford research and development on a big scale and if you coalesce two large firms it means that after a time they've only got one team instead of two and that conserves your technical manpower. And of course when it comes to breaking into any export market, one of the most difficult problems is the cost of examining and exploiting it and breaking into it, which is not only the main aim of market research costing £20,000 or £30,000, and perhaps as well there is a couple of years of unremunerative business. Well, a company with an income of £50,000 a year has got to think twice about that, even if the cost is chargeable for tax. . . . Coalition . . . does tend to help the export drive of the country. But of course lastly the Restrictive Trade Practices Act is another powerful force which is driving these coalitions together. I think on the whole, in the long term, it's beneficial, although it causes all sorts of adjustments in the meanwhile. Because under Trade Assn prices the competition tends to be stimulated, and people tend to come in, unless the prices are delicately adjusted—which they very seldom are. And so one of the new winds of change is blowing round the small people who have been living under the big people's umbrellas.

Sykes: Is there a difficult factor for British manufacturers in that they only have one customer, where the American manufacturers have many and thus have experience in different designs?

Chandos: I wouldn't have thought so. That would presuppose that the American industry . . . is engaged in an immense range of different types of generating equipment. It doesn't work out like that. If you go into any of the American plants, the thing that strikes you are the long runs for the same plant, whereas we . . . are a gigantic jobbing shop. . . . I think that any American . . . would say that the advantages they have are that they make generating plant which is not "one-off" [one of a kind]. But of course that is not necessarily an advantage, in size, steam conditions, and this, that and the other. I think it an illusion to suppose that in fact the number of different customers in the United States leads to more diversity of plant.

Sykes: Here, Sir Christopher Hinton [head of the CEGB] has said that 500 Mw would be the standard unit, and the 2,000 Mw station would be the standard station so that not many units below 500 Mw would be ordered here. Whereas one can imagine in America there are units down to 30 Mw right up to 650 Mw being used.

Chandos: Well, we'd like—if we can—to export the smaller units, and we'd like to have an industry which is flexible enough to be able to manufacture the tailor-made stuff for the particular conditions of the country to which we're exporting. And of course owing to the much lower wages here, the Americans are no longer competitive in that field.

Sykes: Well, finally, Lord Chandos, do you feel there is a future in export of British electrical goods of any kind to America?

Chandos: Oh yes, I think it will be a marginal future, because for one thing I don't think that one of the fundamental industries in America is going to allow any very great extension of imports from Britain nor is the government going to buy foreign imports on a large scale. But that doesn't mean that with such a huge market there's not any outlet for our equipment . . . For ten years after the war, I was not in favor of attempting to break into this stronghold . . . in America, because it would've meant putting our customers that stick with us lower down on the list of priorities. . . . Now that we're not short of capacity, but in fact we have some excess capacity for generating plant, it's quite obvious that we shall here and there break into the American market, on our lower wages and so forth. I think that in terms of our generating capacity in this country, part of it will undoubtedly be taken up by sales of electrical equipment in the United States. Its already quite a large amount—transformers, for instance.

Dixon-Yates Loses Claim In Supreme Court Ruling

Last recourse is to file for High Court rehearing

The US Supreme Court, in a six-to-three decision, has decided the federal government need not pay a nearly $2-million bill claimed by the sponsors of the explosive Dixon-Yates power project. The court's ruling reverses an award to Mississippi Valley Generating Co by the US Court of Claims.

Chief Justice Earl Warren, writing the majority opinion of the court, said the six justices confined their decision only to the question of whether an illegal conflict of interest nullified the contract to build a $100-million power plant near Memphis, Tenn.

And, the court ruled, the dual role of Adolphe H. Wenzell as consultant to the government and vice president and director of First Boston Corp, the investment house which was to take part in financing the project, represented conflict of interest. "We do not think it would be erroneous to characterize (Wenzell) as the real architect of the final contract," the Chief Justice wrote.

A contract to build the plant, designed to supply power to the Atomic Energy Commission through the Tennessee Valley Authority, was signed in November, 1954. It was to have been built by Mississippi Valley, a new corporation formed by Edgar H. Dixon, president of Middle South Utilities, and the late Eugene A. Yates, chairman of Southern Co. President Eisenhower terminated the contract in July, 1955, deciding the need for power would be satisfied by a new plant planned by the City of Memphis. Mississippi Valley then sued the government for $1,867,546 which it claimed it had spent in preliminary work on the plant, and the US Court of Claims awarded this amount to the company. The government appealed the Court of Claims decision.

Justice John M. Harlan, who dissented along with Justices Charles E. Whittaker and Potter Stewart, said of the majority decision: "In a case like this, controlling legal issues are apt to become blurred under the urge of vindicating a public policy whose importance no one will dispute. However, we sit here not as a committee on general business ethics, but as a court enforcing a specific piece of legislation." The Court of Appeals decision should have been upheld, Justice Harlan said.

New Power Pool Forms In Northern Midwest

Under the banner of Upper Mississippi Valley Power Pool, four investor-owned utilities and one electric cooperative have formed an organization to deal with the power needs of parts of Minnesota, Iowa and Wisconsin.

Members of the new power pool are Minnesota Power & Light Co, Northern State Power Co, Interstate Power Co, Otter Tail Power Co and Dairyland Power Cooperative. Engineers from each worked out the pooling agreement. Approval of regulatory agencies is necessary before the agreement becomes effective.

The pool is actually in initial operation now, and will be complete when a 230-kv tie between Northern States and Minnesota P&L is built. This line is expected to be completed in 1963 at an estimated cost of $8.3 million.

The five power suppliers have a combined generating capability of 3,100 Mw.

The new pool should not be confused with other regional pooling plans in which some of the same companies are participating. For example, Northern States and Otter Tail are also involved in another plan in the Dakotas (EW, Jan. 2, p 24). At the present time there are four different plans covering parts of the Upper Missouri and Upper Mississippi basins.

Electric systems of the five utilities in the Upper Mississippi group cover much of an area extending from Lansford, N. D., to Clinton, Ia., which is about 750 miles; and from Ely, Minn., to Sioux Falls, S. D., a distance of about 450 miles.

Reach Agreement on Draft Of Upper Columbia Treaty

Agreement on a draft of the Columbia River Basin Treaty has been achieved by United States and Canadian negotiating teams, and at press time both nations were anticipating early ratification.

In British Columbia, however, BC Lands & Resources Minister Ray Williston said he expects it will be several months before ratification will be an accomplished fact. His views are based on the fact that BC Premier W. A. C. Bennett ordered the provincial Energy Board to conduct a study of Upper Columbia and Peace River developments, and that Bennett has said that there are conditions that may delay treaty signing (EW, Jan. 9, p 28).

Specifically, Bennett is insisting that Upper Columbia power be delivered to Vancouver at the price of 3.77 mills quoted by Davie Fulton, Canada's Justice Minister.

Antitrust Action Filed Against TVA and Others

Owners of 20 under-mechanized mines around Chattanooga are slapping an antitrust suit on the Tennessee Valley Authority, The United Mine Workers, The Louisville & Nashville Railroad, and Industrialist Cyrus Eaton's West Kentucky Coal Co. The suit, filed in US District Court in Chattanooga, could cost the defendants over $30 million.

The mine owners say the four defendants conspired to control the price and production of coal.

The West Kentucky Coal Co and other Kentucky coal mine operators mechanized the Kentucky coal fields. Shortly thereafter, the L&N Railroad lowered freight rates from Kentucky to the TVA areas. The combination of mechanization and lowered freight rates put Kentucky producers ahead in bidding.

Federal law compels TVA to buy from the lowest bidder.

News Scope

SETS DEADLINE—Federal Judge J. Cullen Ganey has set Jan. 19 as the deadline for memorandums from government and defense counsel outlining recommendations and background information to be considered in the sentencing of defendants in the Philadelphia anti-trust cases. Sentencing is not expected until early February, when the government's recommendations also will be made public. Consent decrees in the civil suits are expected to be signed this month. Meanwhile, W. C. Rowlands, Westinghouse Electric Corp vice president, changed his not guilty plea in the turbine-generator case to *nono contendere*. Government failed in its argument against the nolo plea.

HELPING HAND—Atomic Energy Commission has waived $1,650,000 of nuclear-fuel use charges for Consumers Power Co's Big Rock Point Plant. AEC will also reimburse the utility for research and development costs up to $500,000. Under a contract with General Electric Co, AEC will further support the R&D program for the high-power-density, boiling-water reactor to a maximum of $3,710,916, subject to escalation up to 10%, if upward.

SET HEARINGS—Federal Power Commission hearings on Union Co's Taum Sauk 350-Mw pumped-storage power project on Black River, in Reynolds County, Mo., will begin Jan. 31. License hearings are necessary because the FPC staff found the project could affect interstate commerce on East Fork River.

LICENSE ORDERED — Oregon Hydroelectric Commission has been directed to license Portland General Electric Co's proposed $73-million Round Butte project on the Deschutes River. The Oregon Water Resources Board, in issuing the directive, rejected a request by an opposition trout fishermen's group for reopening hearings.

FAVOR AUTHORITY — Three city commissioners—a majority—favor a "Utility Authority" to oversee operations of Memphis Light, Gas & Water Division.

Dateline . . . Washington, D. C. (*Continued from page 5*)

One important case is now before the US Supreme Court, with a decision imminent. It involves gas bought in Texas by Consolidated Edison Co to be transported by Transcontinental Gas Pipeline Corp for boiler fuel use.

This proceeding, involving the FPC's right to consider the end-use of gas, could be crucial to the Mexican project, but Southern California Edison and the other backers say there is little parallel between the situation in the New York City area and their own in California.

What makes Southern California Edison's position in California different?

Smog control regulations in Los Angeles require that Edison burn gas during the six warmer months each year, and Edison's chief source now for this gas is its rival in the gas vs electricity fight, the Pacific Lighting group.

"Our determination to get our own supply of gas at stable prices stems from the fact that we're the only big electric company tied to a competitor for a basic raw material supply," an Edison official says.

"We don't impugn the motives of the gas companies," he adds, "but basic business sense dictates that we have a hand in assuring our own gas supply."

Arguments of conservationists who insist on superior uses for gas are valid only where there is a choice of fuels at competitive prices, Edison says.

These arguments are valid on the East Coast, where both coal and fuel oil can be had, but they don't apply in southern California, the company says.

With steeply rising demand for electricity, Edison argues, there isn't enough coal, fuel oil production is declining, and hydroelectric generation has now been fully developed.

Further, Edison sees its interruptible sources of gas falling off as firm demand for gas increases, and as underground storage facilities for gas are developed.

The gas Edison wants to burn wouldn't be available to California at all if it weren't for the Mexican pipeline plan, Edison says.

First, Humble has adamantly refused to put its King Ranch reserves on the market subject to FPC price control. Under the direct sale to Edison, the FPC has no say on prices.

Second, southern California will become the natural market for untapped Mexican reserves once the pipeline is built, and this gas will be offered to the gas utilities to meet demands in cold weather.

A cloud over the Mexican project developed last month when the FPC and the California PUC authorized El Paso Natural Gas Co to bring 470 million cu ft of gas daily into southern California.

This project, in its early years, depends on big interruptible sales by the Pacific Lighting companies to Edison. The electric company has told the agencies it doesn't want this gas if it can get its own supply.

The degree to which the agencies have prejudged the Mexican project by permitting El Paso's Rock Springs line is uncertain.

Experienced observers predict a compromise that will give southern California both new supplies of gas. But Edison is likely to cling to its demand for a large supply of gas under its control, leaving Edison a substantial new factor in the southern California gas business.

BANKS of 240 v and 2.4 kv are in subsurface housings, reports Philadelphia Electric Co's C. E. Nelson (right)

GLENN DEKRAKER (right), Sangamo, shows Dr E. T. B. Gross, IIT, display of relay for controlling power equipment

Probes Capacitor Experience

Sangamo seminar hears of underground banks for distribution, and of series capacitors for transmission loading

Experience and plans in the application, control and measurement of power capacitors were exchanged by more than two score engineers from about as many utilities at a three-day seminar at Springfield, Ill., sponsored by Sangamo Electric Co. At five topical sessions discussions were led by Dr E. T. B. Gross, Illinois Institute of Technology.

C. E. Nelson, Philadelphia Electric Co, reported that 911 subsurface capacitor bank installations have been made on that system. These include 372 installations of 90-kvar, 240-v banks (15-kvar units) on network and radial mains, and 539 installations of 300-kvar, 2.4-kv banks (50-kvar units) on primary feeders. Since the fall of 1955, only 380 primary banks have been put on poles, Nelson said.

Both secondary and primary capacitor banks are installed in pentatreated lumber housings in the sidewalk area or near the curb. Housings are covered with a steel grating, with a section of corrugated fiber sheet mounted over the capacitors. Life expectancy of the housings is 20 years.

Excluding the capacitors, cost of the secondary installation is $5.18 per kvar; of the primary installation, $2.14 per kvar including the terminal pole connection. These costs include a 36% "accounting cost" to cover certain material overheads. Nelson said that some subsurface 2.4-kv units are switched at a nearby pole, but the 240-v banks are not switched.

Secondary 240-v capacitors make an ideal installation above ground where they can be installed at the customer's connection to network mains. In describing the installation of 500 capacitors on 125/216-v networks, H. L. Peterson, Electric Distribution Department, Austin, Texas, said cost runs $18 per kvar after derating the 240-v capacitor for 216-v operation.

Vaults Required

Capacitors have been installed in banks of 36, 42, or 63 units in old primary meter cabinets of various sizes, Peterson continued. The cabinets are wall mounted midway between transformer vaults and connected to the secondary main through a fused-type replaceable link limiter assembly. Standard secondary network capacitors must also be installed in the vaults to attain the desired power factor correction, he added.

Public Service Electric & Gas Co is installing about 100,000 kvar of capacitor banks per year, said R. M. Havourd, with about 50% each in substations and on poles. Early in 1960 about 605,000 kvar of 2.4-kv pole-mounted units were in place, 285,000 kvar in fixed banks and the rest switched. No unswitched banks have been put in since June 1953, he said.

Load current is generally used by PSE&G as the sensing means where circuits are equipped with induction voltage regulators, Havourd added. But capacitor banks have been used in place of regulators to maintain voltage on the feeder, and space for future regulators may not even be provided in some substations.

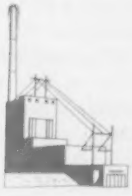
Series capacitors have been found to be the most economical solution when a moderate increase (less than twice) is required in transmission lines of considerable length with minimum insulation levels and when increased loading in parallel lines with large conductors is desired. This was the opinion of E. C. Starr, who added that Bonneville Power Administration has three 230-kv and one 345-kv installations, rated a total of 240,000 kvar.

A series capacitor on a 115-kv line gives very satisfactory control of load division between a "super conductor" line in parallel with other lines having conductors of only one-third the wire size, reported H. L. Deloney, Louisiana Power & Light Co. It has performed without losses of capacitors, capacitor fuses or other components. But line fault

(*Continued on page* 116)

BREED PLANT SITE on the banks of the Wabash River south of Terre Haute is 10 miles from mine that supplies its fuel. Entire output of the 3,500-psi, 1,050/1,050F turbine-generator is transmitted 186 miles north over 345-kv line

THE BREED PLANT STORY



Design concept of a pioneering steam-electric plant producing power in 500-Mw units at supercritical pressure for transmission at EHV from mine mouth to load centers 200 miles away

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S. N. FIALA, Vice President and Chief Engineer,
American Electric Power Service Corp, New York

The concept behind Indiana & Michigan Electric Co's pioneering new Breed Plant called for design of a steam-electric station that would produce power in 500-Mw units at supercritical pressure for transmission at 345-kv from a remote mine-mouth site to load centers in the westernmost part of the American Electric Power System. Placed in operation on July 31, 1960, Breed Plant, it is hoped, will serve as a basic standard for advanced thermal-electric generating practice here and abroad for some time to come.

Operating at 3,500 psi and at a temperature of 1,050F, the unit exploits two stages of reheat, both to 1,050F, and a cross-compound turbine-generator consisting of two 3,600-rpm cylinders, each terminating in a triple-flow, low-pressure element exhausting into its own condenser. Cooling water for the condensers is obtained from the Wabash River on whose banks Breed is located south of Terre Haute, in Sullivan County. Resulting thermal efficiency is expected to be slightly above 40%.

Breed is in effect a mine-mouth plant. Coal for its cyclone-fired boiler is brought into the plant, a distance of 10 miles, over a captive railroad from the Thunderbird Mine of Ayreshire Collieries. The entire output of the plant is stepped up in voltage by two 275-Mva 3-phase transformers and delivered over a 186-mile, double-circuit, 345-kv transmission line into the AEP System at Olive Substation of Indiana & Michigan Electric Co.

In exploiting the supercritical pressure cycle at 3,500 psi and double reheat Breed has stepped back

BREED PLANT

in pressure and temperature from far-reaching levels to attain a new plateau of thermal efficiency. This has been done under terminal conditions carefully evaluated to optimize capital and operating costs and produce energy most economically.

It is proposed to discuss here the basic concepts behind these pioneering undertakings.

The AEP System serves a seven-state area in the industrial heart of the US, covering 48,600 sq miles. Generating capacity is now 6,550,000 kw. During 1960 the system produced 31.1 billion kwhr. This energy was delivered to customers through integrated 138-kv and 345-kv transmission facilities from a series of efficient coal-burning plants with an average heat rate of 9,550 Btu per kwhr.

The rate of growth and behavior of peak loads on the AEP system during the past 30 years is shown in the accompanying graph. It will be noted that system growth has, over a long period, exceeded the ten-year doubling rate of energy production.

Contributing to this growth have been a number of important economic, technical-economic, and social-economic factors relating to location, the growth of smaller communities, abundance of natural resources, availability of highly economical electric energy and a vigorous population.

To provide such virtually unlimited quantities of electric energy at continually decreasing rates, it is necessary to have an economical source or sources of primary energy, economical transportation costs, a well-located plant site and highly developed power plant technology as well as resourcefulness and courage to push power plant design technology as far forward as basic scientific and engineering knowledge permit.

Since the service area of Indiana & Michigan Electric Co has neither sources of fuel nor well-endowed plant sites, it was necessary to go outside the operating area to find water and fuel. Most significantly, in a finding on this question raised before it, the Securities and Exchange Commission clearly established both the right and the responsibility of a utility system to seek and use locations for its plants, regardless of operating area, that are necessary to provide optimum commercial energy supplies.

This idea has been in process of development on the AEP System over a period of 40 years. It started in 1916 with the Windsor Plant delivering power to Canton over a 55-mile, 130-kv transmission line. It was continued with Philo and its 73-mile, 138-kv line to Canton, and it was further developed with Tanners Creek. But it remained for Breed to combine use of 500,000-kw generating units with 345-kv transmission over a single tower line to bring power from an optimum plant site into an operating area almost 200 miles away.

The decision to use electric transportation for this purpose was based on these considerations:

- Solid confidence in the reliability of 345 kv as a bulk transmission voltage
- Favorable economics of electric transmission vs rail haulage even on the first unit installation
- Certain knowledge that electric transmission economics would improve with Unit No. 2 and particularly Unit No. 3
- Conviction that such a decision would be further endorsed with the first increase in freight rates. Such an increase was not long in coming.

The advance in power plant technology signalized by Breed Plant, and its establishment of a new plateau of thermal efficiency and capital economy through adoption of a 3,500-psi, supercritical-pressure, double-reheat cycle is no new-born concept on the AEP System. Its roots go back to the conviction that both thermal and capital economies lie along the road to higher steam temperatures and more effective use of materials. For many years, new plant construction and existing plant additions were engineered and scheduled to match projected growth by systematically adding virtually-identical units of interchangeable design, interspersed with fairly large developmental installations to test out new ideas.

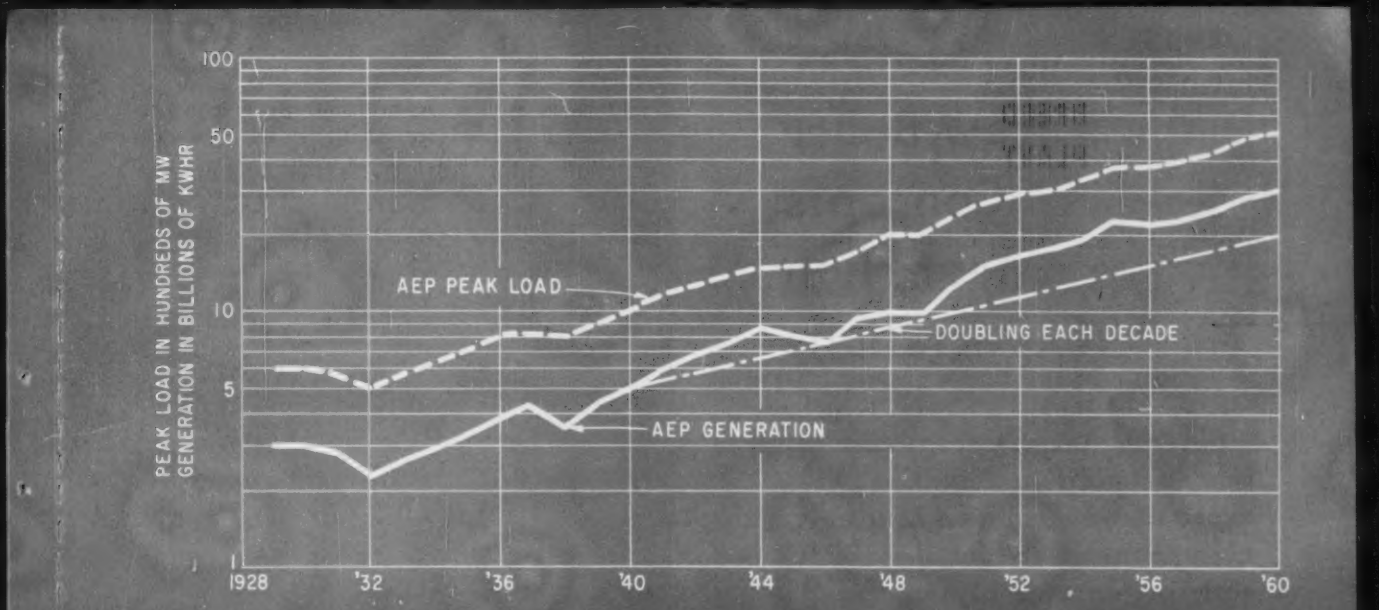
Extrapolation Must Be Conservative

Size extrapolation is particularly important. Experience over a long period has demonstrated that extrapolation, to be economically successful and attainable, must be quite conservative. The ratio generally should not be greater than 2:1. A convincing example of this practice is the 77,500-kw, 2,500-psi, 940/900F single-boiler, single-turbine generating unit placed in operation in 1941 at Twin Branch Plant. Experience with this unit led to the post-war installation of seven similar units, each designed for 150,000-kw, 2,000-psi, 1,050/1000F reheat operation. All austenitic material was used on six of these machines in the high temperature parts of the turbine, including turbine piping and valves. In the last unit of this series, less expensive ferritic materials were substituted to check the suitability of this type of construction for 1,050F high-pressure steam service. Results were better than expected.

Successful design, manufacturing and full-scale test of ferritic materials at 1,050F service led to another projection in size, this time to 215,000-kw net output. It brought a further improvement in efficiency due to the increase in size and reheat temperature from 1,000 to 1,050F. This led to a long line of excellent production units which in later versions were expanded to 225,000 kw, making the next step more difficult.

It was obvious that an increase in unit size alone would not achieve the necessary control over rising equipment and construction costs. Substantial improvement in thermal efficiency had to accompany the next size projection. We faced the particularly difficult problem of introducing new ideas into the designs of natural-circulation boilers which had sufficient promise to insure progressive improvements in larger sizes. Much larger and thermally inflexible steam drums, with equally undesirable heavy-walled pressure parts, made the once-through type of design necessary and particularly urgent because of the rapid system load growth.

To gain this experience, The Babcock & Wilcox Co and General Electric Co cooperated with us in extensive studies and later in the design, construction, and



GROWTH RATE OF AEP annual peak load and generation has long exceeded the ten-year doubling rate

operation of the first supercritical pressure unit placed in service at Philo Plant.

To provide maximum opportunity for accelerating this type of design, steam conditions of 4,500 psi for the turbine and 5,500 psi for the boiler were matched with 1,150F steam temperature and two stages of reheat, 1,050/1,000F. Placing of this 120-Mw pioneering unit in commercial service provided much-needed prototype experience to enable development of larger units with better-balanced terminal conditions.

Philo No. 6 gave us many things:

1. A most versatile steam generator design with new opportunities for improvement in nearly every phase of arrangement and use of materials

2. A low specific volume of steam that enhances optimum shapes in high-pressure turbine parts

3. The introduction of a completely new concept in boiler water technology

4. Improvements in water purification equipment and techniques which add to availability

5. An automatic control of the Philo unit which has proved to be simple and responsive. Apropos of the last and of particular significance is the drastic reduction in time required to cool the steam generator before a scheduled outage or to re-start the unit from either a hot or cold condition.

Almost four years of operation of the Philo supercritical unit has completely borne this out. Philo No. 6, now in its fourth year of operation, continues to be highly satisfactory in all respects.

The Breed Plant is the first commercial unit based on Philo No. 6 knowledge, design, and operating experience. Notwithstanding some delays and unexpected and painful troubles, it is now performing better than expected. The Breed project was announced in 1956 (EW, Dec. 24, 1956, p 74) as the first of two 450-Mw supercritical units to be installed on the AEP System. The second unit was later scheduled as an addition to the Philip Sporn Plant. This unit, too, has now gone into commercial operation. Now rated at 500 Mw, the turbine-generators are identical except that the generator stators on the Sporn machines are water-cooled, while the Breed stators are oil-cooled. Water-cooling, so far proven entirely successful on the Sporn unit, should add materially to compactness of future high-capacity stators.

Although operation of the supercritical unit at Philo demonstrated the feasibility of 1,150F as a suitable mate for 4,500 psi, industry has been unsuccessful in producing low-enough-cost high-temperature materials to justify their cost from the resulting thermal gains. The steam conditions on the Breed unit, therefore, were set for what then appeared to be the most attractive combination of 3,500-psi, 1,050F high-pressure steam, with two stages of reheat, both to 1,050F. Our work since 1956 has not only confirmed this but has shown further economic gain in dropping initial and first-reheat temperatures 50 and 25 deg respectively.

Breed Performance Is No Stopping Place

The new plateau of performance provided by Breed (and Sporn) cannot serve as a stopping place. Both from the standpoint of the electric industry and the country, it would be tragic if that were permitted. It should, therefore, not be surprising to know that work is being done on the further development of the supercritical pressure cycle, exploiting larger units, and with initial and reheat temperatures going up on an ascending scale instead of down on a descending one. A particular target is improvement in capital cost, reliability, and lowering of maintenance costs based upon the experience with the 500-Mw units.

The detailed description of the Breed 500-Mw development in the accompanying articles will, it is hoped, give a clear account of the basic ideas of its various component parts. Even more ardent is the hope that it will stimulate others to push the Breed frontier forward, to build better on Breed knowledge and to insure for this country a continuation of its world reputation for outstanding performance by its power industry.

New Boiler Concepts Meet High Expectations

Less fluid pressure drop than expected, well-balanced heat absorption, stable control mark early performance of once-through boiler based on Philo prototype

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P. H. KOCH, Manager, New Products Examination Engineering, and
E. M. GRIFFIN, Field Supervisor, Service Engineering, Babcock & Wilcox Co, Barberton, Ohio

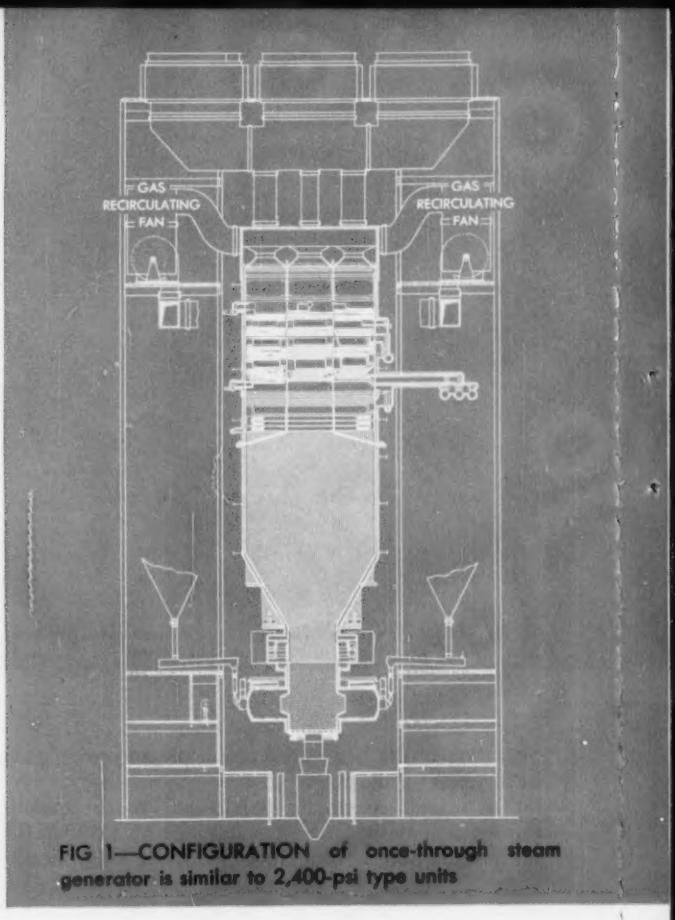


FIG 1—CONFIGURATION of once-through steam generator is similar to 2,400-psi type units

The steam generator for the Breed 500-Mw unit produces 3,250,000 lb of steam per hour at 3,500 psi and 1,050F and has two stages of reheat, each to 1,050F. Experience gained at Philo Station in the design and operation of the first prototype supercritical-pressure steam generator provided the knowledge and confidence necessary to build the single-furnace unit for Breed Plant.

The Philo prototype had been designed to fit into an existing plant. Thus its size and configuration could not be considered the best possible from a commercial standpoint. Consequently, in designing the steam generator for the Breed unit, it was necessary to develop new concepts, to simplify materially the arrangement and reduce first cost.

Although major difficulties were encountered during startup of this unit, because start-up transients were not fully anticipated, all of these difficulties have now been satisfactorily corrected and the performance of the unit has met or exceeded expectations.

- Lower than expected fluid pressure drop, along with well-balanced absorption in the furnace and the convection sections, has made it possible to achieve a continuous steam output of 3,250,000 lb per hr.
- Steam temperature and pressure controls have been stable during normal operation and also during load swings of 240 Mw at rates of up to 40 Mw per min.
- Hot restarts have been accomplished easily by the normal operating personnel in less than one hour.

Modifications Were Necessary

The unit was fired for the first time on February 14, 1960. But between that date and June 21, when the unit was paralleled with the system, the following modifications were found necessary:

- Both the lower furnace and its cyclones are supported from top steel by eight "U" loops, 150 ft high, located outside the furnace walls. These support loops must be maintained at a temperature close to the average enclosure temperature to minimize differential expansion between the upper and lower furnace walls. This is done by circulating a portion of the fluid from the upper furnace outlet through the support loops.
- In the original design the inlet and outlet of each loop was connected upstream and downstream of orifices in the furnace outlet piping. Although these orifices were correctly sized for the load range, they were not satisfactory for the startup transient conditions. The low specific volume of the fluid passing through the orifices during startup resulted in very low flow through the support loops with much of the heat in the fluid transferred to the heavy-wall support tubes. Consequently, the fluid density difference between the down-flow and the up-flow legs of the support tubes was great enough to overcome the orifice pressure drop and stop flow through the support tubes. Circulation in the support tubes was changed to down-flow in both legs by installing a pipe from the bottom of each support loop to a point further downstream in the furnace outlet piping, and relocating the orifice downstream, thus making both down-flow. This modification required less pressure drop than the alternate

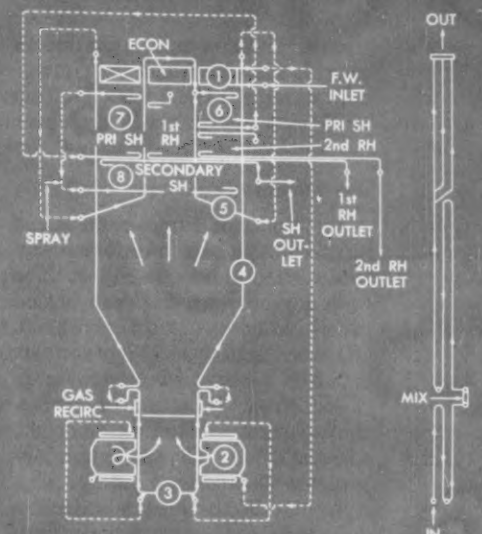


FIG 2—STEAM AND WATER FLOW as shown. From economizer feedwater flows to outside downcomers, to cyclones, lower and upper furnaces and superheater

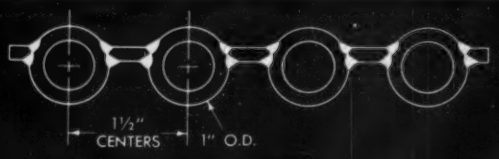


FIG 3—MEMBRANE WALL is key feature of furnace

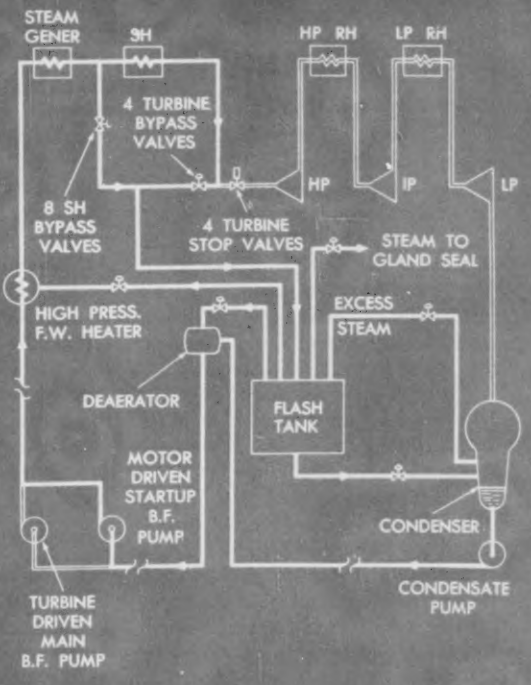


FIG 4—BY-PASS SYSTEM to handle start up flow is essential to once-through forced-flow steam generator

of merely reducing the size of the original orifice. (See also piping article page 68.)

When attempting to bring superheater outlet temperature to 850F for the first time, a tube failure occurred in the down-flow, second-section of the primary superheater. Because this tube failure occurred near the top of the superheater, fluid recirculation was suspected. Additional thermocouples were installed and data obtained showed that recirculation was taking place during startup transient conditions. The recirculation was due to small fluid temperature unbalances which resulted in density differentials large enough to overcome the relatively low resistance to flow through this down flow section. This section of primary superheater was changed to up-flow to assure a positive flow through each section during all phases of operation.

• When superheater outlet temperature was brought through the transition temperature of 710-730F, steam temperatures in the four main steam leads varied as much as 200F. The spread in temperatures occurred each time the steam temperature was raised through a transition range, and was due to flow stagnation in one or more of the steam leads. This stagnation occurred because small fluid temperature unbalances resulted in density differentials sufficiently large to overcome the relatively low resistance to flow through the down-flow steam leads.

• Secondary superheater outlet steam piping was modified to provide pressure equalization and a partial mix of the fluid. This assured flow through all sections of the secondary superheater during all start-up transient conditions and thereby prevented excessive spread in the steam lead temperatures. The maximum spread of steam lead temperatures during start-ups after the alteration has been about 25F.

Two Basic Differences Considered

Two fundamental differences must be carefully considered between the conventional 2,400-psi, 1050/1,050F, single-reheat, drum-type steam generator and the 3,500-psi, 1050/1,050/1,050F double-reheat steam generator. These are:

1. A unit designed to operate at 3,500 psi must be of the once-through forced-flow type because no boiling occurs at supercritical pressure and there is not enough density differential to obtain satisfactory circulation.

2. A unit designed for 2,400 psi must provide for absorption of half the total heat input for generating steam and half for superheating and reheating. A 3,500-psi unit, on the other hand, must provide for absorption of one-third the total heat input for generating steam and two-thirds for superheating and reheating. This heat distribution requires the use of gas recirculation to avoid placing superheater surfaces in gas temperatures of about 2,700F.

Once these two fundamental differences are resolved, many of the design features that have been tried and proven in drum-type units can be incorporated in a supercritical unit.

The general arrangement of the steam generator is shown in Fig 1. In configuration it is similar to several drum-type units operating at 2,400 psi. It is about 250 ft in

BREED PLANT

height from the slag tank to the top of the air preheaters. The upper furnace and convection section are 52 ft wide and 42 ft deep and are supported directly from top steel. The lower furnace and the cyclone furnaces are bottom supported from fluid-heated support tubes which in turn hang from the top steel.

Crushed coal is fired in eight 10-ft dia cyclone furnaces which are arranged in a single row in both the front and rear walls of the fully studded lower furnaces. Recirculating gas is introduced at the top of the lower furnace, which is only 18 ft deep, and, after mixing with the furnace gas, flows through the upper furnace which is enlarged in depth to 42 ft. The gas then flows up through a convection heat-absorbing section consisting of the secondary superheater, the first and second stage primary superheaters, the high-pressure reheater, the low-pressure reheater and the economizer.

Three vertical-shaft regenerative air preheaters are above the convection section. The unit is located outdoors and is pressure-fired with no provision for induced draft.

The flow of steam and water through the unit is shown in Fig 2. Feed-water from the high-pressure heaters flows up through the economizer and then through outside downcomers to the cyclone furnaces. After passing through the cyclone furnaces, the water flows through the lower furnace and then to the upper furnace where the transition from water to steam occurs. The steam then goes through the superheater screen, the primary superheater, and finally the secondary superheater.

Factors Affecting Furnace Design

Furnace and burner geometry have a pronounced effect on heat absorption in both the furnace and the convection heat absorbing surfaces of a steam generator. Since heat absorption has a large influence on metal temperatures, it is important that the furnace and burner geometry result in a good distribution of heat throughout the unit.

The relatively low ash fusion temperature of the fuel, coupled with the small percentage of the total heat that must be absorbed in the furnace, led to the use of opposed-cyclone-furnace firing and gas recirculation. The relatively small, fully-studded, lower furnace facilitates wet slag removal over a wide operating range and, further, aids in thorough mixing of the recirculating gas with the products of combustion. Recirculating gas—about 30% at full load—is introduced at the top of the lower furnace to temper the combustion gas below the slagging temperature before they enter the convection passes and to assure an even heat input to the large upper furnace and the convection surfaces.

Tests Show Best Furnace Shape

Model tests were conducted in the laboratory to determine the most desirable furnace shape, cyclone-furnace location, and arrangement of recirculating gas entry into the furnace. Field tests have confirmed that the heat absorption rates in the furnace, the superheaters and the reheaters are exceptionally well-balanced as a result of the good mixing of the combustion and the recirculating gases.

One characteristic of forced flow through multiple parallel tubes heated in a furnace is fundamentally different from that in a natural circulation system. With forced flow, the tubes receiving higher heat input have proportionately less flow than those receiving less heat, whereas with natural circulation, those tubes receiving more heat have the higher flow rate. Therefore, with forced flow, it is imperative that both fluid and heat distribution in the furnace be carefully balanced.

At Breed, water flows through the cyclone furnaces in a combination of series and parallel flow paths (Fig 2). This flow pattern is such that the fluid temperatures leaving all the cyclone furnaces, regardless of the number in operation, are balanced and close to the temperatures of the furnace walls to which the cyclones are attached. Entering the bottom of the lower furnace walls, the water then flows in an up-down-up path to the lower furnace outlet, where all the fluid is completely mixed. It then enters the upper furnace and flows through a similar path. After leaving the upper furnace and convection enclosure, it is given a second complete mix before entering the screen and the convection surfaces. The transition from water to steam occurs in the upper furnace walls.

Use Membrane Furnace Wall

An important feature of the Breed furnace design is the membrane wall construction shown in Fig 3. The walls are constructed of shop-welded panels made up of 1-in. to 1⅛-in. OD tubes spaced on 1½-in. centers with the space between the tubes closed by a $\frac{3}{16}$-in.-thick bar, machine-welded to both sides of the adjacent tubes. This membrane construction has these advantages:

1. Part of the heat absorbed in the web is conducted to the rear of the tubes, permitting the back of the tubes to become heat transfer surfaces.

2. Raising metal temperature on the backs of the tubes reduces thermal stresses by reducing the temperature differentials through the wall.

3. Fluid mass-flow through the walls can be maintained at desired levels without using a large number of fluid passes.

4. Pressure-drop through the furnace circuits is less than it would be with tangent-tube construction because the fluid contacts less internal tube surface.

5. Weight of steel per sq ft of wall area is some 35% less than for tangent tube walls.

6. Rigidity is greater than for a tangent tube wall using the same tube diameter.

7. Erection time is reduced.

Comprehensive analytical and experimental investigations were performed to determine the behavior of membrane walls under combined mechanical and thermal stresses and to establish the best membrane tube configuration and the best design of attachments, supports, and buckstays. Field experience at Breed and other operating units has confirmed the soundness of the membrane enclosure design.

The convection heat absorption section consists of three parallel gas passes. The secondary superheater and the economizer extend across the entire depth of the convection section. The first and second stage reheaters are located in separate gas passes and all but a small part of the primary superheater is located

in the third gas pass. At full load, the gas temperature entering the first section of secondary superheater, which is on 18-in. side spacing, is approximately 2,200F.

Start-Up By-Pass System Details

During start-up of a drum-type boiler, heat absorbed in the furnace walls starts and maintains water circulation. The principal limitation on firing rate is that of the gas temperature entering the superheater. A once-through forced-flow steam generator, on the other hand, depends upon its feed pump to provide the required minimum water flow through circuits exposed to high gas temperatures. Thus, a by-pass system to handle this start-up flow is essential (Fig 4). While circulating the start-up flow, the by-pass system has the following functions:

1. Reduces pressure from above-critical in the steam generator to below-critical in the flash tank.

2. Provides a source of steam for the turbine seals.

3. Provides a source of steam for the generator.

4. Uses a large portion of the heat in the fluid entering the by-pass system to heat the feedwater in the high-pressure heaters.

Turbine by-pass valves in the Philo prototype were designed for one-third of full-load flow at 950F. However, to reduce both the start-up time and initial investment, the Breed unit was designed to start-up with only 10% of full-load flow through the turbine by-pass, with the remainder of start-up flow through lower-temperature, less-expensive, superheater by-pass valves.

During normal cold start-up, a water flow of 1,100,000 lb per hr is established through the turbine by-pass valves and, as the temperature of the fluid leaving the secondary superheater reaches 500F, turbines seals and the deaerator are put into service, using steam from the flash tank. At 600F, steam from the flash tank is available for heating the feedwater. Above 650F the specific volume of the fluid is such that the turbine by-pass valves will no longer handle the 1,100,000-lb-per-hr flow and the superheater by-pass valves begin to open. At 850F the flow through the turbine by-pass has been decreased to 350,000-lb-per-hr and steam conditions are satisfactory for rolling the turbine.

BOILER INSTRUMENTS AND CONTROLS are in central control room from which operator has push-button control of all operations of the plant

The use of flash tank steam to heat the feedwater greatly reduces the time and the heat input required for startup. A cold startup, with water at 80F, requires firing for 2 hr at about 17% of full-load heat input.

When a unit is tripped at high load, heat in the slag on the floor and walls must be dissipated. In the drum-type boiler, this heat is absorbed in the furnace walls and circulation continues until the slag is cooled. The Breed unit, however, has a single feed-pump driven by turbine-extraction steam. Consequently, feedwater flow stops when the turbine trips. To provide the required cooling flow through the furnace circuits, a special valve has been installed between the economizer inlet and the primary superheater connecting piping. This valve opens automatically if the unit trips and facilitates natural circulation through the furnace and economizer to prevent localized overheating or excessive temperature differentials.

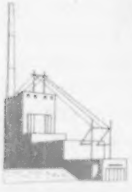
The start-up by-pass system can be used to advantage when cooling the unit following a trip-out or normal shut-down. A feedwater flow of 1,100,000-lb-per-hr is immediately established through the turbine and superheater by-pass valves to the flash tank. Deaeration and near full-load feedwater temperature are maintained using steam from the flash tank. The rate of cooling is controlled to the desired limit by regulating the amount of steam used to heat the feedwater and by-passing the remainder to the condenser. In this manner, the unit can be cooled and entered for inspection or maintenance in less than four hours without any excessive temperature differentials in the steam generator, steam leads, or turbine stop valves.

Steam Temperature Control

Main steam temperature is controlled by adjusting heat input, and reheat steam temperatures are controlled by proportioning gas flow over the reheater surfaces. There are four separate superheater outlet headers and four main steam leads. Since the steam in the four leads is not mixed before entering the turbine, four spray attemperators are installed between the primary and the secondary superheaters to assure equal steam temperatures in the four leads. The amount of attemperation required for balancing temperature at full load averages about 1.0 to 1.5% of the total feedwater flow. There are no other attemperators in the control system of the steam generator or in the start-up system.

FIG 1—BREED TURBINE ROOM has HP unit on left and boiler feed pumps visible in left background. The 500-Mw cross-compound machine has identical shaft speeds. Note absence of crossover pipes between shafts. Only crossovers are from exhaust of 2nd reheat turbine to inlet of double-flow sections

Simplicity Is Key to Effective Turbine Arrangement



Equal shaft loads permit duplicate generators, exciters, and transformers; locations of turbines on the two shafts simplify HP and crossover piping

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The Breed turbine-generator is a 500-Mw cross-compound 3,600/3,600-rpm unit, operating on supercritical steam at 3,500 psi and 1,050F with double reheat to 1,050F. The duplicate generators are conductor-cooled.

Arrangement of the Breed turbine has a number of attractive features: The division of output between the two shafts is essentially equal at all loads making possible duplicate generators, exciters, buswork, and transformers. Second-reheat and low-pressure turbines are duplicates. Location of the high-pressure and first-reheat turbines on different shafts makes a simpler layout of the high-temperature piping. There are no crossover pipes between the two shafts and therefore the layout problem associated with large crossover pipes between shafts was eliminated. The only crossovers go from exhausts of the second-reheat turbine to the inlets of the double-flow sections and they are quite short. This, coupled with location of intercept valves on shells of the first and second-reheat turbines, results in small entrained steam volumes and keeps down overspeed on loss of load in spite of the low moment of inertia of turbine and generator rotors relative to their output.

In the Breed machine the combination of large volume flow and steam conditions of 3,500 psi, 1,050F made use of four stop valves desirable. They are located ahead of the turbine (Fig 2), the above-seat chambers are connected by equalizer pipes about the same size as main steam inlets. The equalizer between the two inner valves serves as a chest for the four main stop valves and for a startup valve which bypasses the four main stop valves.

By-Pass Valves Aid Startup

Turbine by-pass valves are used to provide the necessary flow of water or steam through the boiler during startup. They are sized to pass about 240,000 lb per hr of 3,500 psi, 950F steam and will pass about 1 million lb per hr of 3,500 psi, 600F water. By-pass valves are located so they serve as drain for the main steam piping and above seat chambers of the main stop valves. But they do not cool off and fill with water when they are closed and the turbine is running. Since they stay hot, they can be opened immediately after a shutdown without being subjected to rapid temperature change.

The four main stop valves feed steam to two control valve chests on each side and near the floor of the HP turbine. There are four control valves in each chest. Two servomotors in the base under the turbine

LEGEND

A MAIN STOP VALVES
B TURBINES BYPASS VALVES
C STOP VALVE BYPASS VALVE
D CONTROL VALVES
E HIGH PRESSURE TURBINE
F FIRST REHEAT STOP VALVES
G FIRST REHEAT INTERCEPT VALVES
H FIRST REHEAT TURBINE
J SECOND REHEAT STOP VALVES
K SECOND REHEAT INTERCEPT VALVES
L SECOND REHEAT & SINGLE FLOW LOW PRESSURE TURBINE
M DOUBLE FLOW LOW PRESSURE TURBINE
N GENERATOR
O EXCITER

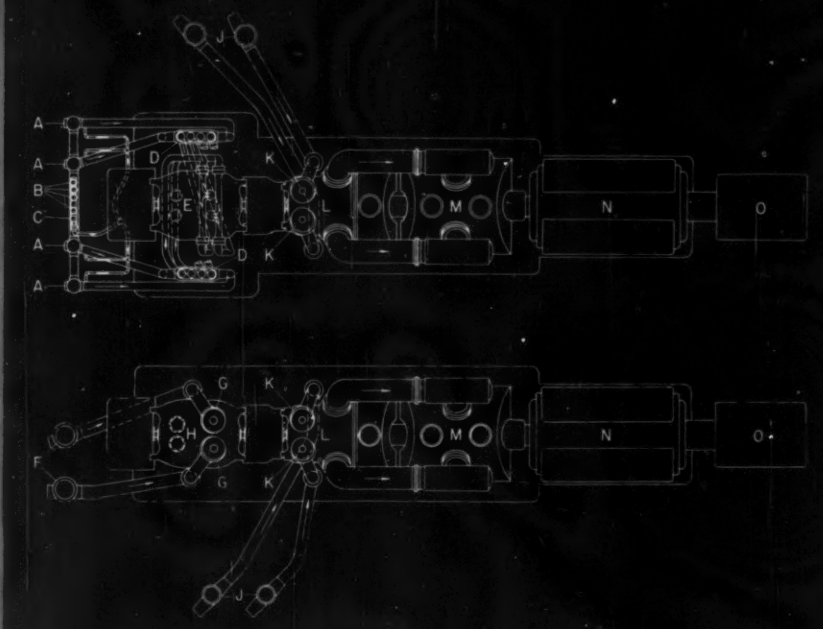


FIG 2—ARRANGEMENT of the two shafts of Breed turbine-generators. The identical generators are conductor cooled. Location of HP and 1st reheat turbine on different shafts made HP piping simpler

front standard operate the control valves through cam-actuated mechanisms. Eight valves feed the four main steam connections on the HP turbine and are piped so each HP turbine inlet is fed by one valve in each chest.

The HP turbine has seven single-flow stages. It uses double-shell construction throughout. Steam enters through four individual all-welded nozzle boxes. Inlet tubes of these nozzle boxes are sealed at both inner and outer shells by ring joints that provide leak-proof seals, yet permit axial and transverse motion between nozzle boxes and shells.

Steam after leaving the HP turbine at about 1,000 psi is reheated to 1,050F in the first reheater and returns to the first reheat turbine through two parallel reheat stop valves and two intercept valves.

The first-reheat turbine has six single-flow stages and uses double-shell construction throughout. A suitable ring joint seals the two inlet connections which come through the outer shell and admit steam to the 360-deg arc of the first stage.

After leaving the first reheat turbine at about 300 psi, steam is again reheated to 1,050F and returns through four parallel reheat stop valves and four intercept valves, two sets of which are associated with each of the two turbine shafts.

There are two six-stage second-reheat turbines, one on each shaft, to handle the large flow with buckets of reasonable length. They are single-shell machines even though inlet temperature is 1,050F. This is possible because reheat pressure is only 300 psi and thus the shell and bolting stresses are reasonable for a single shell. Steam is extracted from the two second-reheat turbines at about 85 psi to supply the 20,000-hp variable-speed condensing turbine which drives the main boiler feed pump.

The low-pressure turbine of this cross-compound set is a six-flow design with 26-in. last-stage buckets having a total annulus area of 246.6 sq ft. There are three sections of this low-pressure turbine on each shaft with one of these in the same casing with the second reheat turbine. The other two sections are in the third casing, which is supplied with steam through two top-mounted crossovers. The three sections of the low-pressure turbine discharge into a common connection to the main condenser.

Each shaft of the cross-compound set has six main turbine bearings and two generator bearings. Each of the rotors is supported by two bearings with solid flanged couplings in between. The main thrust bearing is an independently mounted, taper-land design, located between No. 2 and 3 bearings in the middle bearing pedestal. Each shaft is provided with a main shaft-driven oil pump that supplies oil to the control mechanism at 225 psi and to the bearings at 25 psi.

The front standard of the primary shaft contains the speed governor and the pre-emergency governor for two of the low-pressure intercept valves. The front standard of the secondary shaft contains two pre-emergency governors, one for the high-pressure intercept valves and the second for the other two lower-pressure intercept valves.

Turbine Operating Experience

In the interval between June and November the Breed turbine was started cold 14 times; hot four times. With one or two minor exceptions, it started smoothly and ran satisfactorily over the load range. Control of metal temperature change in starting and loading does not appear to be a problem. Experience in starting under conditions of full load dump and immediate hot restarting is required to evaluate this aspect more fully.

The Breed turbine has operated exceptionally well since the unit was started in June 1960. However it was not without its share of shake-down difficulties. Many of these were typical of the sort that occur

BREED PLANT

on a subcritical-pressure machine. But three are of particular interest because they are related to the large size and high steam conditions of the Breed turbine.

The first concerns erosion of targets downstream of the turbine by-pass valves. These cup-shaped parts, inlaid with ⅛-in. Stellite No. 6, didn't withstand operation with cold water and were replaced with 1-in. cast Stellite cups. Recent inspection showed only slight erosion since June. However, these targets must be considered wearing parts that may require replacement every few years.

The second concerns the control valve operating mechanism. It bound so tightly when pressure built up in the valve chest that the valves would neither open nor close. This was caused by excessive friction in cam shaft bearings, which were a graphited bronze type. The high lifting forces for the 3,500-psi valves, combined with simultaneous opening of three of the four valves, produced more friction than is normally experienced. Installation of roller bearings on the cam shaft overcame the difficulty.

The third involved a condition of shaft instability or "oil whip" at No. 2 bearing of both shafts at higher loads. It occurred in the first reheat turbine in September while engineers were trying to determine maximum capability of the machine. The trouble is believed to be related to the high steam forces on the relatively light rotors and possibly to a shift in loading between No. 2 and 3 bearings. Tilted-pad bearings were installed in the first-reheat turbine in September and it has operated satisfactorily since. The high-pressure turbine has also proved to be marginal from a stability standpoint and the unit is operating at slightly reduced capacity until the tilted pad bearings can be installed on this rotor.

Operating experience with Philo No. 6 supercritical pressure machine has served well as prototype for the Breed turbine-generator. However, the size and cross-compound arrangement of the Breed unit made modifications necessary in the starting procedure. Early plans to pressurize the control valve chests during the speed change from 1,000 to 3,600 rpm were altered to a procedure where this is done at rated speed to avoid unnecessarily long operation in the range of shaft and bucket critical speeds.

Time to bring the turbine up to speed was set at 10-15 min for either cold or hot starts instead of using longer times for cold starts. Steam conditions at startup are 3,500 psi, 850F. The turbine is brought up to speed using the stop valve by-pass with control valves wide open. After full speed is reached, pressure is built up in the control valve chests using temperature difference across the valve chest as guide. The allowable differential varies from 260F to 160F depending on metal temperature. The higher value is permitted below 400F. Time for pressurizing the steam chest varies from one hour for a cold start to just a few minutes for a hot start.

After paralleling the unit, load is raised to hold the first stage shell wall temperature difference below 150F. At 100 Mw, load control is transferred to the pressure governor from the synchronizing device. The turbine control valves maintain throttle pressure, and load control is transferred to the boiler feed pump. Further increases are made with either the motor-operated or turbine-driven boiler feed pump.

Load is increased as determined by the proper heating rate to about 180 Mw, using the motor-driven boiler feed pump. At this point the turbine-driven pump is started and flows from the two pumps are paralleled. The motor-driven pump is shut down as the turbine-driven one is loaded. The motor-driven pump can carry the unit to about 280 Mw; the turbine-driven one can carry the unit down to about 150 Mw.

Generators Are Conductor-Cooled

Generators driven by the high-pressure and low-pressure turbines are duplicate 3,600-rpm machines each with a capability of 291,500 kva, 85% power factor at 45 psi hydrogen pressure. Generator voltage is 16.5 kv.

Generator stator and rotor windings are made of hollow conductors through which coolants flow. The heat produced by the conductor losses is, therefore, absorbed directly in the coolant with the elimination of the large temperature differentials through the main insulation such as exist on conventionally-cooled machine. For the same temperature rises, winding current capabilities are considerably increased, permitting a substantial reduction in the size of frame and core. For example, these generators have the same core lengths previously used in conventional hydrogen-cooled generators rated 147,059 kva at 30-psi hydrogen pressure and 0.64 short circuit ratio.

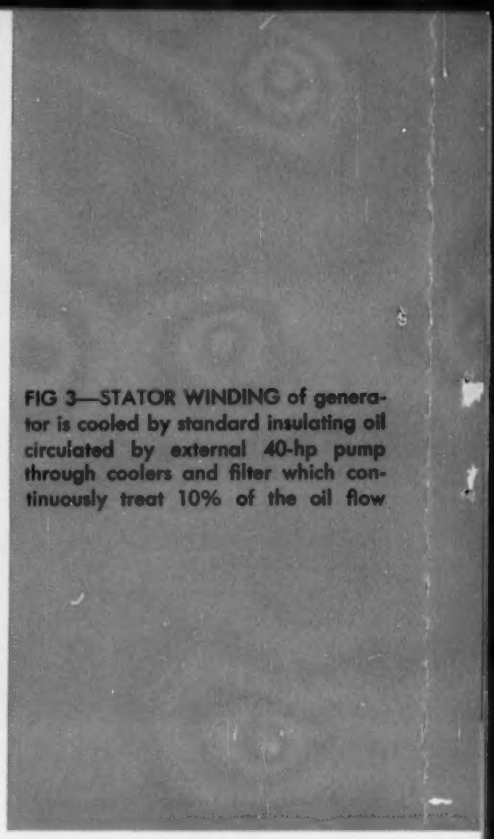
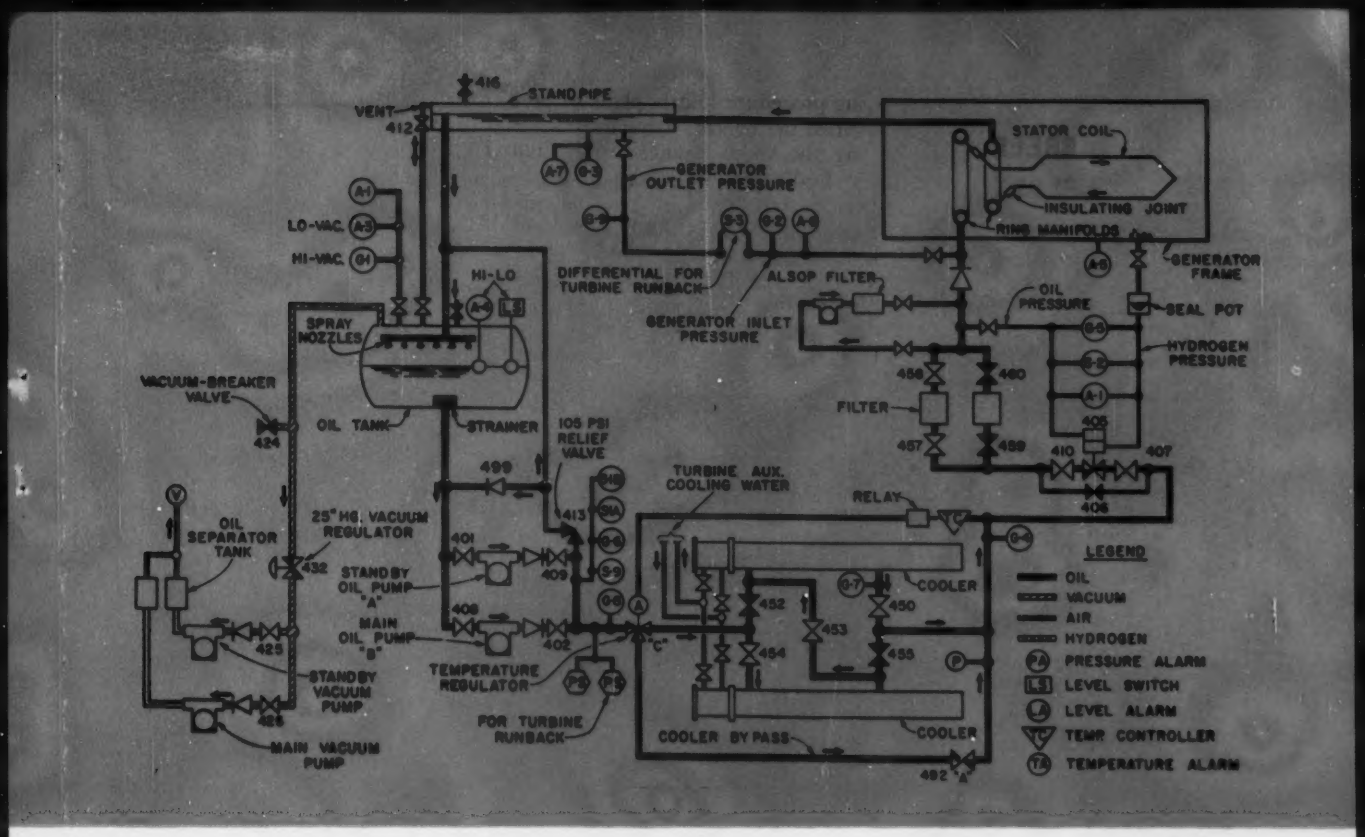


FIG 3—STATOR WINDING of generator is cooled by standard insulating oil circulated by external 40-hp pump through coolers and filter which continuously treat 10% of the oil flow

The stator winding is cooled with standard insulating oil circulated by an external pump through coolers and filters. The transil oil is inhibited with 0.6% DBPC (Di-tert-butyl-para-cresol).

Cooled oil enters each of the top stator bars at the turbine end, flows to the exciter end and returns through the corresponding series-connected bottom bars to the turbine end of the generator. Oil connections are made to the inlet and outlet oil headers, which encircle the end winding at the turbine end. The headers are connected to the external oil system as shown (Fig 3). The external system is com-



prised of an oil reservoir in which the oil is vacuum treated at 25 in. Hg; two 40-hp oil circulating pumps, one of which is standby; two filters, one of which is a standby; two series oil coolers and a filter, which continuously treats 10% of the oil flow.

Thermal expansion and contraction of the stator winding during load changes are limited by automatically controlling the inlet oil temperature. This temperature is held constant by varying the amount of oil bypassing the coolers. Winding temperature variations are minimized in this way because the copper is always within a few degrees of the temperature of the oil.

As Fig 3 shows, an oil pressure regulating valve is provided that automatically holds the inlet oil pressure to a value of 3 psi below the hydrogen pressure. Thus, should hydraulic leaks develop in the generator, oil would be prevented from leaking into the generator.

The stator winding is protected against overheating by an automatic load runback system which operates if oil flow and pressure are lost for any reason. If oil pressure is not restored by the back-up pump before a short time limit, unit load is lowered by the BFP turbine so that output of each generator is reduced to a safe value without oil flow.

The rotor winding is cooled by hydrogen scooped from the air gap. Hydrogen flows about 2 ft axially within the conductors before being discharged to the gap and to radial outlet ducts through the stator core. Since the body portion of the rotor does it own pumping through the short parallel passages, the normal single-stage, low-pressure fan is all that is needed to ventilate the rotor and turns and the stator core. All the hydrogen passes through horizontal coolers, which are perpendicular to the axis of the generator in the top of the stator frame.

Generator bushings are gas cooled. They have a self-cooled rating of 5,900 amp and a gas-cooled rating of 12,000 amp, based on a copper temperature of 100C.

Generator performance to date has been comparable to that of a conventionally-cooled machine where trouble-free operation is the rule. Since these are the first liquid cooled generators on the AEP System, oil samples were taken and analyzed every two weeks at first. Subsequently the samples have been taken monthly. Inter facial tension, color, neutralization number, specific gravity, dielectric break-down voltage, power factor, inhibitor content, water content and rotary bomb oxidation tests were taken and after four months of operation no significant deterioration of the oil was noted.

While it is anticipated that the flow of cooling oil will be interrupted only on very rare occasions, if ever, tests were conducted at Breed Plant to determines the capability of the generators without cooling oil flow. These tests showed that a load corresponding to 50% of the generator 45-psi hydrogen capability can be continuously carried with 46C cold gas temperature and 30-psi hydrogen pressure. Normally the cold gas temperature is maintained at a temperature less than 40C.

Typical generator operating temperatures are as follows for a generator load of 250 Mva, 99% power factor with 30-psi hydrogen pressure:

Inlet oil.....**37C**
Outlet oil.....**75C**
Max. Stator RTD.....**52.3C**
Cold gas.....**36C**
Hot gas.....**46.5C**
Field winding.....**89C**

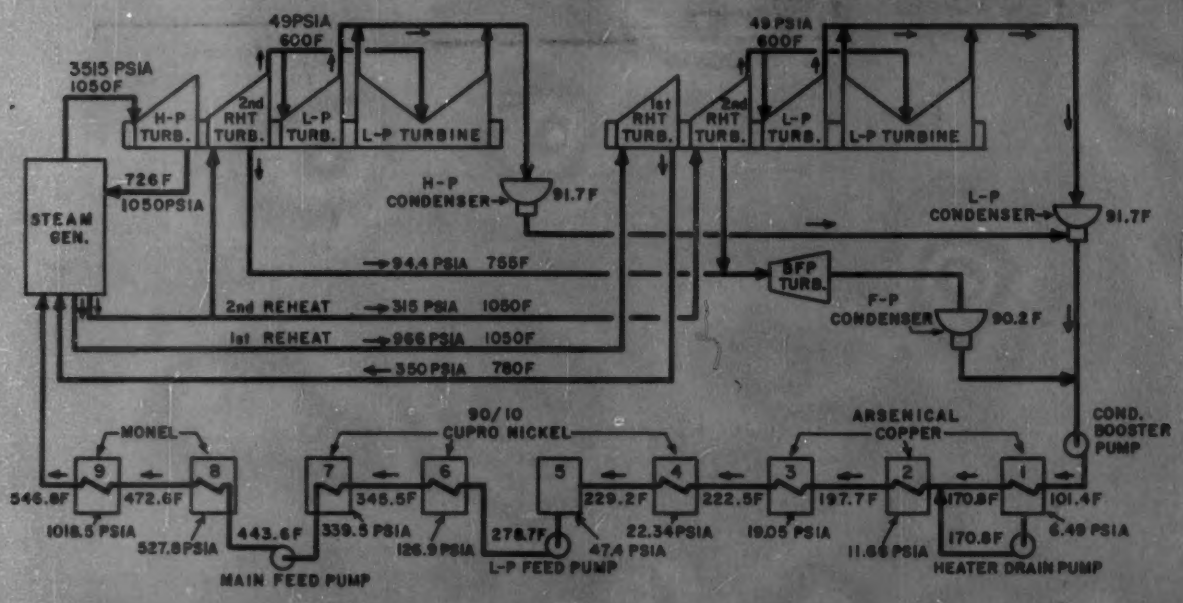


FIG 1—DESIGN HEAT BALANCE diagram for Breed unit provides for gross generation of 478,000 kw and auxiliary needs of 25,000 kw. Net design heat rate of 8,566 Btu per kwhr corresponds to net generation of 453,000 kw

Heat Cycle Refinements Yield 8,376-Btu Heat Rate At 480 Mw

Improvements in heat cycle affecting startup and normal operation work with high rated unit using double reheat at 1,050F to yield 40% thermal efficiency

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The design for Breed Plant was based squarely on the prototype design of Philo Unit No. 6. Economic considerations for a production unit dictated reductions in steam conditions, but, a low over-all design heat rate of 8,570 Btu per kwhr was indicated. This was approximately equal to the design heat rate at Philo and was made possible by higher internal efficiency of the turbine, due size and design improvements, and to refinements in the heat cycle affecting normal operations and heat rejection during startup.

Simplified design heat balance for the Breed Plant is shown in Fig 1. Its significant features are these:

1. Supercritical steam pressure of 3,500 psi at turbine throttle

2. Double reheat

3. Large unit rating giving a throttle flow of about 3,250,000 lb per hr

4. Single full-size boiler feed pump driven by a 20,000-hp condensing steam turbine

5. Combustion air heating by steam extracted from the turbine

6. A separate, closed turbine auxiliary cycle delivering heat from oil coolers, hydrogen coolers and gland leak-off condenser, to the condensate steam

7. Sub-cooling of distillate on its way to storage

8. A high-pressure flash tank to separate steam and water and deliver steam to the deaerator and the highest-pressure feedwater heater during startup.

These features have been remarkably successful in achieving not only the high-efficiency levels predicted, but in actually bettering them. Detailed water-rate tests have been made on the turbine and associated heat-cycle equipment, and the resulting net plant heat rates, both design and tested, are shown in Fig 2 for various loads. At a net generation of 480 Mw, net plant heat rate is 8,376 Btu per kwhr compared to a design heat rate of 8,570 Btu per kwhr at 453 Mw. Both rates are based on design values of steam generator efficiency (90.9% at 453 Mw), since efficiency tests have not been run on this piece of equipment.

Factors Improving Performance

Contributing to these improvements in performance is a turbine internal performance some 1% better than expected, and lower auxiliary power as indicated in Fig 2. The improved turbine performance, we believe, is better than expected due to the sophisticated design of the turbine steam path and to a somewhat more potent

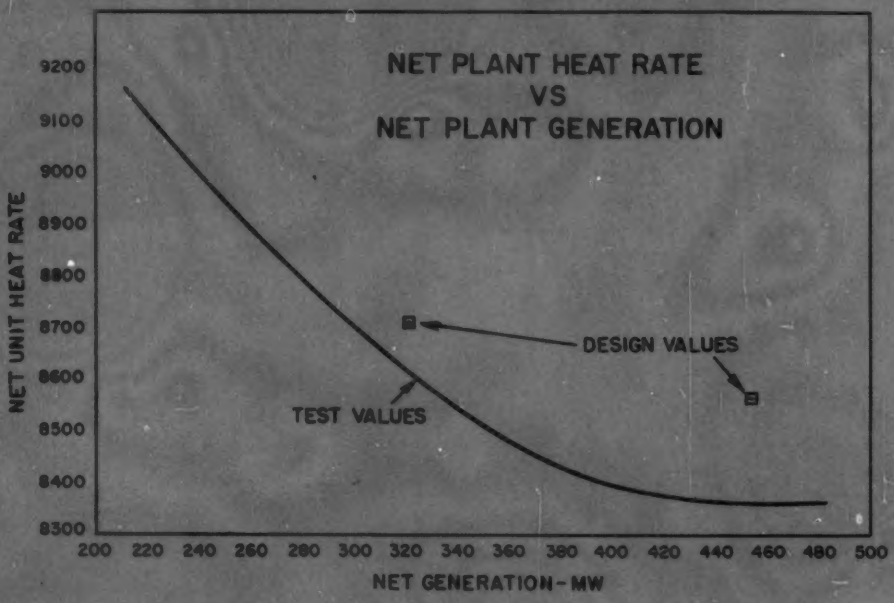


FIG 2—NET PLANT HEAT RATES reflect effect of turbine internal performance 1% better than expected due to design of steam path. Size effect too was more than expected. Also design estimates of auxiliary needs were conservative

than anticipated size effect. Moreover, design estimates of auxiliary power requirements were conservative; running some 1% better than measured amounts.

Highest efficiency was designed into the cycle at every possible point. Experience gained in the design first of Philo and then of Breed and its sister unit Philip Sporn No. 5 have given confidence that these features contributing to high efficiency can be provided by simpler, less-expensive means in future units.

With the initial operating pressure of 3,500 psi the selection of reheat conditions was studied carefully. Double reheat at 1,050F gave a gain of about 2% and was included as being economically attractive and adding no operating complication. Reheat pressure-level studies showed that the highest efficiency occurred when the entropy increases across the high-pressure and first-reheat turbine stages were about equal. The change in efficiency, as pressure is varied, is not sharp. Therefore the two reheat-pressures were set at 1,000 psi and 330 psi for mechanical considerations. The most potent was the volume flow through the second reheat system and the first turbine stage after reheat. By setting initial reheat pressure relatively high, at 1,000F, heater extraction point temperature was suitable for 545F water temperature, and no extraction was taken from the high-pressure turbine. To moderate the loss due to use of highly-superheated steam in feedwater heaters, the heaters next below the two reheat points were depressed in pressure so that the temperature increase in each of the two heaters on the cold reheat points was about 1.5 to 1.75 times the average rise in all heaters.

Turbine Drives BF Pump

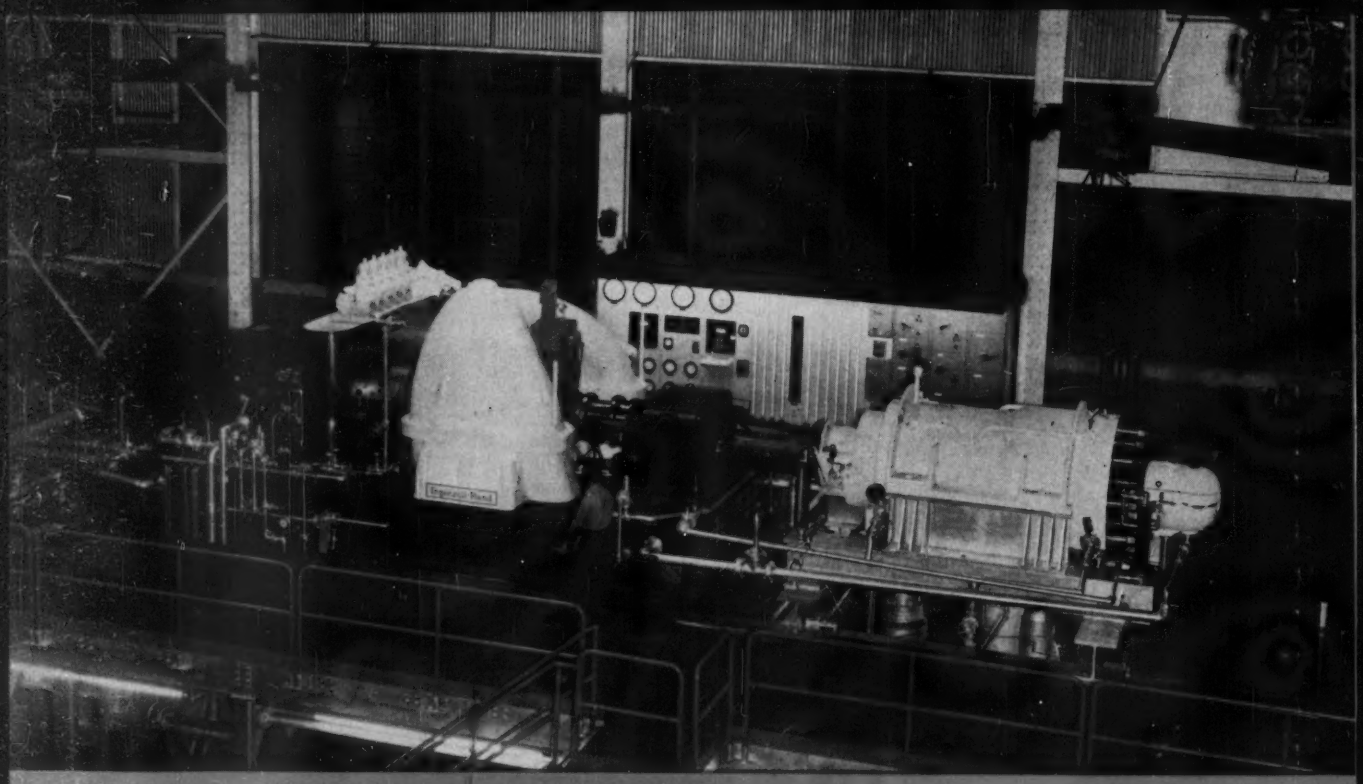
Good experience with single turbine-driven feed pumps encouraged use of such a pump drive for the full supply of feedwater. Experience with nine such 225-Mw units, together with Breed and Sporn No. 5, has confirmed the soundness of this basic philosophy and demonstrated that a single turbine-driven boiler feed pump can be designed with features of high reliability and lowest over-all cost.

Turbines serving feed pumps on the 225-Mw units are non-condensing, extraction machines that exhaust to a heater and extract steam for two others. Throttle steam comes from the high-pressure turbine exhaust. This arrangement makes for a small, high-speed turbine and a reasonably small thermodynamic gain, due to the cooler extraction steam. But it does have certain complications for starting, heater outage, etc.

At Breed it became apparent, however, that with the relatively heavy exhaust-annulus loading on the six ends of the main machine, it would be attractive to add, in effact, a seventh end. This was done by using a condensing BFP-drive turbine that takes steam from a low-pressure level in the main machine to shorten the energy range on the turbine and so by-pass as much steam as practical around the main exhaust.

With a condensing BFP turbine, moreover, lower speeds are more attractive to avoid expensive double-flow exhaust design. Final selection called for a 20,000-hp turbine with throttle steam at 100 psi, 750F, 1.5-in. Hg exhaust, 3,600 rpm and a mating 10-stage feed pump rated 7,200 gpm 11,050-ft head at 3,600 rpm.

This condensing arrangement provided the highest flexibility and improved the over-all unit net heat rate 25 Btu per kwhr at 450 Mw net output (40 Btu per kwhr at 500 Mw). Duct work connecting the exhaust of this turbine to the main condensers was considered but rejected in favor of a separate



BOILER FEED PUMP on test. Rated 21,600 bhp it handles 7,200 gpm of feedwater at 4,550 psig discharge pressure

BREED PLANT

18,000 sq. ft. condenser connected on its air outlet and hotwell to the main condenser system.

Operation of this turbine and pump has been most satisfactory with no outage of the turbine traceable to this equipment. Pump efficiency has been about 3% better than its high guarantee. However, an unexpected and unsatisfactory surge condition has been experienced at low flow conditions. This is assessed as a function of the low attack angle between water and impeller; accentuated by a high ratio of eye-to-impeller diameters. Model studies are expected to resolve the basic cause of this phenomenon; the only unforseen result of a large extrapolation in pump design.

Since 1951 extraction steam has been used to operate combustion air preheaters at highest effectiveness with high sulfur coals. It was used at first on 150-Mw units at Philip Sporn as a modification to raise outlet gas temperature and reduce excessive air heater fouling. Later its thermodynamic attractiveness led to its use in various forms.

Studies Improve Preheaters

Initial designs of the regenerative air preheater called for three 26 ft dia, 48-in. deep preheaters each with 118,000 sq ft surface. Inlet air was to be raised 25 F in small extraction heater coils. Later studies showed however that fouling would not be a problem with a final air heater metal temperature of 240F. This could be held by raising inlet air heater temperature to 152F while lowering stack-gas temperature to 284F. This called for more surface in each air heater, raising it to 283,000 sq ft and calling for three 28-ft dia units 86 in. deep. These changes improved overall unit heat rate 100 Btu per kwhr. Steam for the steam coil air heaters comes from the vapor space of the deaerator and condensate drains back to it by gravity.

High-pressure feedwater heaters are expensive at 4,500 psi tube-side design pressure. This led to a compromise heater arrangement in which an intermediate stage of feed pumps is introduced. Pump power varies directly with specific volume of the water, but tends to rise rapidly above 400 F. Efficiency with which the cycle reconverts feed pump power to output also increases with temperature. Studies showed that optimium net heat rate was achieved if water was pumped at 300F. But this called for three costly high-pressure heaters. A compromise was struck among heater cost, pump power, and heat rate by putting three half-size low-pressure feed pumps under the deaerator. They pump through a single-line of heaters (No. 6 & 7) and deliver water at 700 psi, 425F to the main feed pump. Twin-stream heaters (No. 8 & 9) were provided as being less costly and giving operating flexibility by permitting full flow through either stream. Terminal temperature differences were evaluated on all heaters. Tube materials are shown in Fig 1.

In a split pump arrangement like this, care must be taken to assure adequate net positive suction head on the higher pump. At Breed every

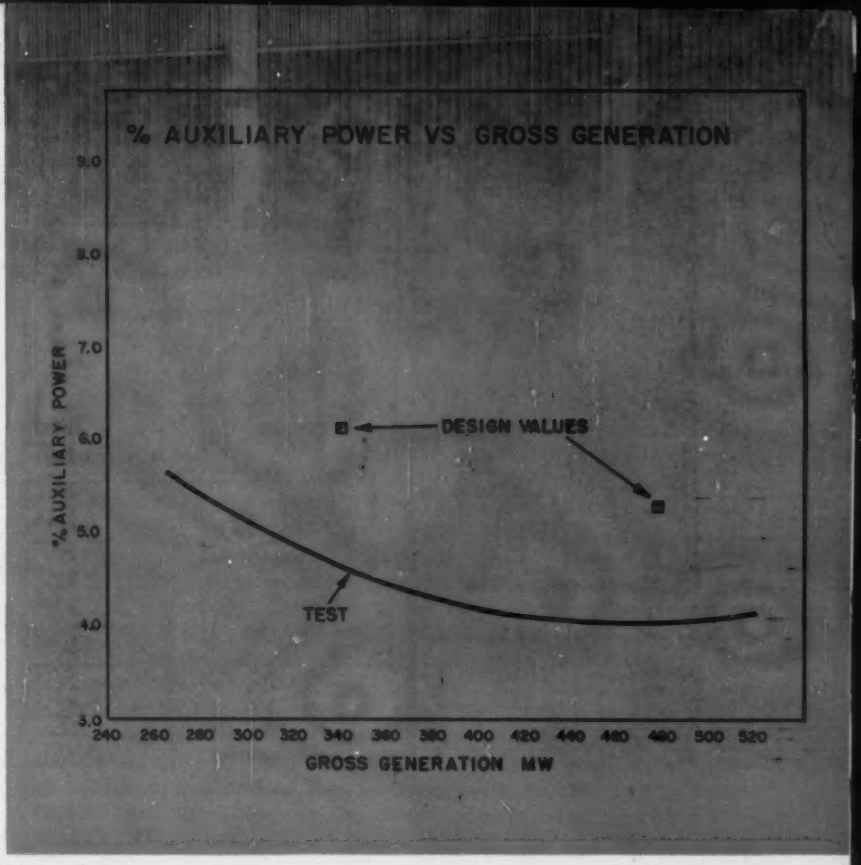


FIG 3—AUXILIARY POWER needs based on early performance tests were about 1% under early conservative estimates

precaution was taken to guarantee trouble-free operation of LP feed pumps, including floating bushings on the shaft seals. On low pressure a trip operates to shut down the main feed pump.

Several aspects of the startup system for a once-through boiler (See page 50) affect the heat cycle equipment; particularly the requirement of ⅓ flow through the boiler for startup. This is provided at Breed by a wound-rotor, motor-driven, feed pump rated 3,600 gpm at 11,050 ft head at 3,600 rpm. Motor speed is 705 rpm with a speed increase to 3,600 rpm. Speed is varied by a liquid rheostat in the rotor circuit. Half capacity was picked instead of one-third because of the small incremental cost between the two, and to provide overlap between the load where the main pump drops out and the motor driven auxiliary can operate.

The main pump can no longer carry the unit when load is reduced to about 30%, due to the drop in extraction-stage steam pressure that serves it. This increases the specific volume of the steam and shortens the energy range through which it expands. For the inlet area selected for the first stage of the main pump turbine, control valves are 70% open at full load and gradually close and then reopen as load is reduced. Valve opening is 100% when unit load is reduced to 30%. Hence transfer of pumps must be made at that time.

Deaerator Included In Cycle

To deaerate water to the highest degree, deaerating condenser hotwells were purchased and a deareator included in the cycle. Deaeration of the highest quality is an important, positive feature to eliminate oxygen problems. During cold startup, undeaerated water is pumped through the cycle from the condenser at atmospheric pressure, through the heaters, boiler, bypass valves, flash tank and back to the condenser. The flash tank, however, has been designed to operate at 1,000 psi and includes water level control equipment as well as cyclone separators and scrubbers to separate the steam and water phases. As soon as water from the boiler reaches 220F or more, steam is taken from the flash tank to start to peg the deaerator. The only heat thrown out of the cycle is in the saturated water taken from the flash tank to the condenser. By the time outlet fluid temperature reaches 400F the deaerator is fully-pegged at 3-5 psig and high-level deaeration achieved. At the same time steam is taken from the flash tank to turbine shaft seals and a vacuum can be pulled on the condenser.

As fluid temperature leaving the boiler rises, average enthalpy of the fluid entering the flash tank increases and pressure rises. A special pegging valve between the flash tank and No. 9 heater lets bypassed steam be conserved up to the max. design feedwater temperature of 545F. In this way a minimum of heat is lost from the cycle during startup.

The turbine auxiliary cycle is novel in its provision for startup conditions and recovery of all heat from oil coolers, hydrogen coolers and gland seal leak off condensers during operation. A completely-isolated stream was provided with pumps circulating condensate through the turbine auxiliaries and then either through a turbine auxiliary heat exchanger sending the heat into the main condensate stream or to a turbine auxiliary cooler, dumping heat to circulating water. This auxiliary cooler acts during startup or periods of high back pressure when temperature needs of hydrogen coolers cannot be met by condensate.

Two evaporators provide high quality makeup for polish demineralization and filtration. Vapor from these is condensed in an evaporator condenser and cooled to nearly ambient temperature enroute to storage in a counter-flow heat exchanger that heats incoming treated water feed from the evaporators.

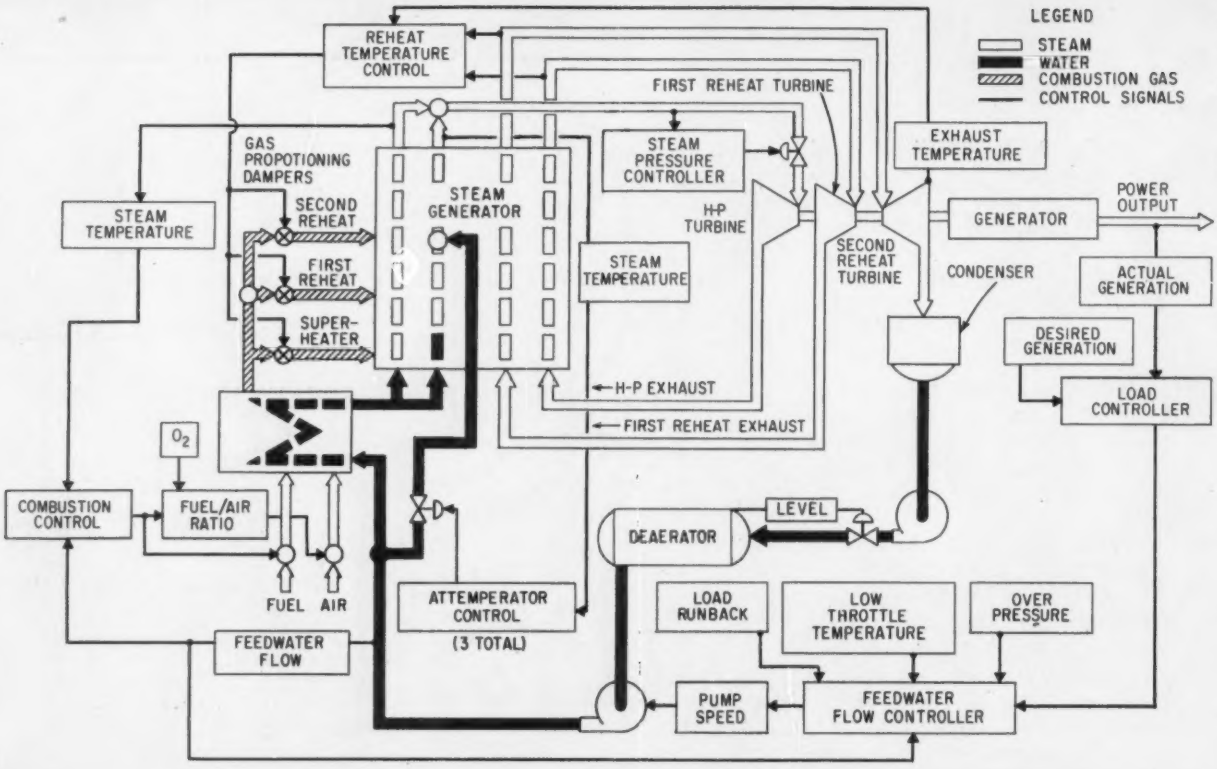


FIG 1—UNIT CONTROL DIAGRAM illustrates coordination of boiler and turbine-generator controls. Desired generation, the primary control signal, is applied manually by the operator or automatically by the system load control

Station Controls Are Closely Coordinated

Central control room also includes Dequine Sub, Breed switchyard, and coal handling system as well as analog computer to monitor thermal performance

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The instrumentation and control for Breed Unit 1 extends the centralized control philosophy developed on the AEP System in the past 20 years. The unit is provided with a central control room in which are located all the instruments and controls necessary to start up, operate, and shut down the unit as well as the controls for coal handling, the transmission switchyard, and Dequine Substation located some 90 miles away. In addition, the control room houses the instrumentation, including an analog computer for monitoring the thermal performance of the unit.

Use of a once-through type steam generator requires such close coordination of the boiler and turbine-generator controls that in effect they become one control system. A simplified diagram of these controls is shown in Fig 1. The primary control signal, which is desired generation, may be applied manually by the operator or automatically by the system load control. This signal sets the rate of feedwater flow to the steam generator while a sub-control loop adjusts the pump speed to maintain the desired rate of flow.

Steam pressure at the turbine throttle is controlled by positioning the turbine control valves. Under emergency conditions, the turbine speed governor can limit the turbine control valve opening to control overspeed, and a pressure limiting control then comes into action to reduce feedwater pump speed to hold the throttle pressure to a safe value.

Spray Attemperation Used

Firing rate is adjusted to control the main steam temperature at the desired value. Since there are four superheater sections in parallel, maintaining equal outlet steam temperatures is done by spraying a fixed quantity of water into the inlet of one superheater section and using its outlet temperature as the control signal for the combustion control. The other three sections

are equipped with conventional spray attemperators to control their outlet temperatures to the same value as the control section.

The combustion control loop uses feedwater flow rate and steam temperature as the two control elements. The control loop acts to balance the energy input of the steam generator to the feedwater flow rate. Deviation of steam temperature from the desired value causes a correction to be applied to energy input. The combustion control has proportional plus reset response with a very minor amount of rate response. The proportional response is adjusted automatically to compensate for the number of cyclones in service.

Valves Eliminated

The spray attemperator controls have proportional plus parallel reset and rate responses. Originally there were two water control valves for each superheater section, but changes made to the steam generator after preliminary operation led to eliminating one of the valves in each set. The superheater section, used as the control section for the firing rate, also has a spray attemperator control to protect against abnormally high steam temperature caused by misoperation of the firing controls.

The combustion air flow and fuel rates are controlled in parallel with automatic correction of the overall fuel-air ratio from automatic analysis of the exit flue gas. Gas analyzers at each cyclone outlet correct the fuel-air ratios of the individual cyclones. An accidental loss of a substantial part of the firing capacity causes a low steam temperature override controller to reduce the feedwater flow rate to correspond to the limited firing rate.

Three sets of gas proportioning dampers control the distribution of energy among the two reheaters and the superheater. These dampers are positioned to maintain each of the two reheat steam temperatures at its desired value. The second reheat steam temperature must be reduced under conditions of low load and high turbine back pressure to prevent the turbine exhaust steam from being superheated. This is done by providing a set point adjustment from the turbine exhaust steam temperature controller.

The superheater and both reheater temperature controls receive a common set point signal. This set point signal is related to the feedwater flow rate so that the three steam temperatures increase linearly from 1,000F at ⅓ load to 1,050F at ⅔ load and above.

Fits System Load Control

The Breed unit is equipped with conventional control devices to participate in system load and frequency control. However, the method of applying the load control to this unit is different. The control drives an electro-pneumatic converter instead of the turbine governor speed changer motor. The pneumatic output of this converter changes the set point of the feedwater flow control, in turn, causing the required change in unit output.

This unit does not respond to normal changes in system frequency through speed governor response. The speed governor is normally set at its high-stop, well out of range of normal frequency changes. The turbine control valves, under these conditions, respond only to changes in throttle pressure. This feature puts considerable emphasis on keeping the load-frequency control equipment in service. All of the load control equipment including deviation recorders and set point control is located in the unit control room at the Breed Plant.

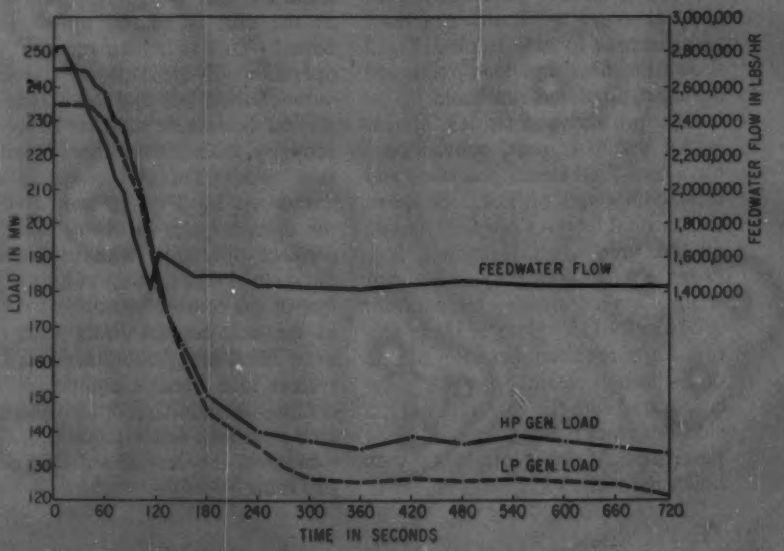
Two sets of by-pass valves and a pressure breakdown system provide the required flow capacity to bypass the turbine during steam generator startup. One set of valves receives water or steam from the inlet of the turbine stop valves, which are operated sequentially from a hydraulically driven cam shaft. The second set of eight valves is connected to the outlet of the first section of primary superheater. These valves are air-operated with their positioners adjusted to open the eight valves two at a time.

The control system is single-element, operating to maintain the throttle steam pressure at a preset value. Either or both sets of valves can be automatically controlled. When both sets of valves are in service, there is provision for changing each set's participation so that a smooth transfer may be made. Pitot tubes in the main steam leads determine the portion of flow through the turbine bypass valves under startup conditions.

Load Run-Back Test

The generators have liquid-cooled stators. If the cooling liquid flow stops, the generator kva must be reduced to within the hydrogen cooling system capability, about half of the maximum capability. In this case, the load run-back controller

FIG 2—RUN-BACK TEST shows that load decrease lags feedwater flow by about three minutes because of steam stored in reheaters and piping



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slows the boiler feed pumps at a rate that will reduce the feedwater flow from full to half load flow in two minutes, stopping when half load flow is reached. The normal action of the throttle pressure controller closes the main turbine control valves as necessary to maintain throttle pressure.

Positive protection for the generator in case stator cooling flow is lost is provided by a second independent run-back control. This backup device is initiated after a time delay and runs the main turbine speed and load adjustment handwheel motor in the lower direction to close control valves. This run back will override the throttle pressure controller to close the control valves if necessary.

Unity Power Factor Maintained

Voltage regulators on the unit will hold unity power factor on the generators under run-back conditions through the reactive ampere limit circuitry. This has two advantages: 1) It increases the kw load the unit can carry, easing the load the system must absorb; 2) It provides increased margin between the required feedwater flow and the minimum flow trip point.

Electrical load is not reduced as fast as feedwater flow because of steam stored in the two reheaters and connecting piping. If a run-back is initiated at full load, about five minutes elapse before load is reduced to 50%. This has proven fast enough to limit generator temperatures to safe values. Fig 2 shows the flow and load reduction during a simulated run-back.

The protective interlock system is, for the most part, conventional for a coal-fired steam generator and cross-compound turbine. Some of the unusual features are the tripping of the unit when feedwater flow drops to 875,000 lb per hour or when main steam temperature drops to 790 F. Both of these features are required because of the once-through steam generator. Incorporated with the conventional gas side interlocks, these provide the permissive firing interlock with boiler ignitors.

Past experience has shown the need for additional data to analyze properly generator faults, and therefore this unit was equipped with an oscillograph to supervise the generator equipment. Eleven traces were provided—four generator currents, two generator voltages, two generator neutral voltages, two generator field currents, and one timing trace. Also, 20 off-on traces were provided to back up a trip sequence monitor which provides a time sequence record of the operation of all tripping devices.

The excitation system consists of shaft driven exciters with amplidyne voltage regulators.

The location of the plant with its associated long transmission lines required an excitation system with a response of 2.0 instead of the conventional 0.5 to reduce the possible overvoltage caused by tripping of the remote ends.

The generator fields are equipped with thyrite discharge resistors instead of the conventional linear resistor. The thyrite discharge resistor was added to reduce the generator terminal voltage more rapidly, providing faster fault clearing on the high voltage equipment. Initial testing indicates the generator terminal voltage is reduced more rapidly than was the case with the linear resistor.

Absorbed Dispatcher Duties

A unique feature of this plant is that the unit foreman and control operator have absorbed the duties of the system load dispatcher in addition to operation of the unit.

The location of the plant requires some unusual switching procedures as the unit is started up or shut down. This switching requires the operation of breakers at the Dequine Substation and operation of several disconnect switches to locate properly reactors on the transmission lines. These disconnects are monitored by TV cameras so that the operator can supervise the disconnect operation without leaving the control room. Supervisory control of the remote station is located in the unit control room with the local switching equipment. The system load control equipment including deviation recorders and the area and limit setter console is also located in the centralized unit control room.

The unit is equipped with an analog computer and the necessary measuring equipment to compute turbine gross heat rate, high pressure turbine and first reheat turbine efficiency, top feed water heater and condenser performance.

Performance Monitored

Condenser performance helps the unit operator decide when to backwash the condensers. The computer calculates the deviation in performance from that expected at existing condenser load and circulating water temperature.

Automatic gas analyzers measure excess air entering and leaving the air heaters to determine air heater leakage and to help make boiler efficiency calculations. Since the air heater seals can be adjusted in service, automatic measurement has been of considerable benefit in maintaining minimum leakage.

The control system, following a brief tune-up period, has performed quite well. During load run-back tests, throttle steam temperature was held within ten degrees of the set point while reducing steam flow from 3,000,000 lb per hour to 1,500,000 lb per hour in two minutes. About 25 minutes after the start of the run-back, a minor disturbance of the steam temperature occurs. This is due to the colder feed water, resulting from the load reduction, upsetting the heat distribution in the steam generator. The feedwater temperature does not drop appreciably for about three minutes after the start of the run-back because of the slow rate of decay of the first reheater steam pressure. Then an additional 25 minutes elapse before the fluid representing this colder feed water reaches the superheater outlet.

Some trouble was experienced at the start in controlling flash tank level. Originally, the drain valves were sized to handle the full by-pass flow with virtually no pressure drop. As the steam generator is fired, these valves handle less and less flow with the pressure drop increasing to about 750 psi. A change permitted maintenance of 175 psi air pressure in the flash tank until the bypass flow became hot enough to flash into steam at this pressure. This permitted reducing the drain valve capacity appreciably with substantial improvement in response.

Clean-Up System Prevents Feedwater Contamination

Stringent control of feedwater quality must be maintained during break-in, start-up, and normal operations

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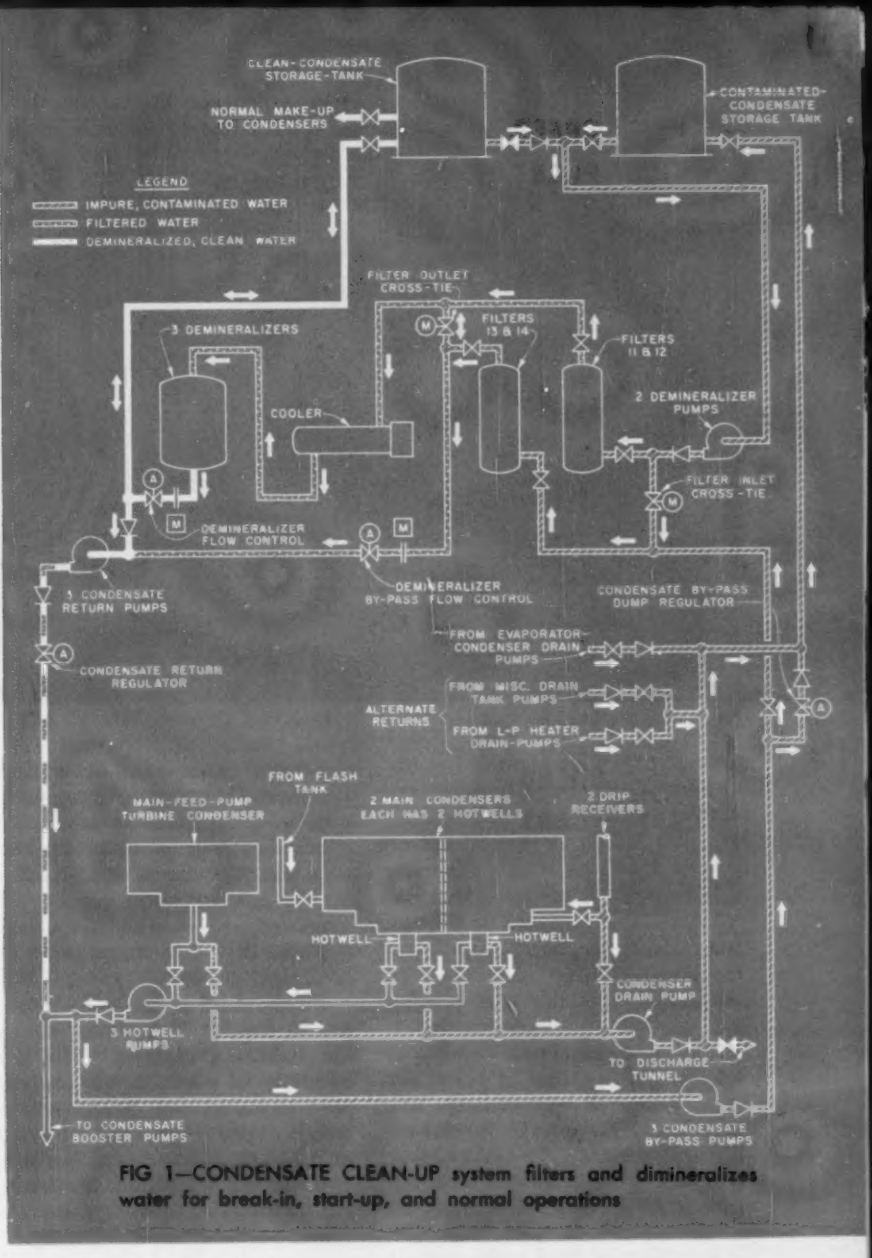

FIG 1—CONDENSATE CLEAN-UP system filters and dimineralizes water for break-in, start-up, and normal operations

Operation of the Breed unit has amply demonstrated the need for stringent control of feedwater quality. The clean-up system must prevent feedwater contamination for normal as well as breaking-in operation. Feedwater specifications for normal operation are shown in the table.

The condensate clean-up, or polishing, system is designed to operate together with the bypass system during start-ups, as well as during normal operation. Fig 1 shows features of the clean-up system which is designed to:

1. Clean the condensate stream by filtration and demineralization for start-up and normal operation.

2. Handle condenser leakage for a deferred or short-time orderly shut-down, depending on leakage severity. Condenser hotwells are sectionalized to accomplish this.

3. Polish make-up evaporator vapor condensate.

4. Clean contaminated heater and other miscellaneous drains normally entering the cycle downstream of the filters.

5. Divert the entire condensate flow to storage at start-up and normal operation to one-third load. This reduces contaminant load on the clean-up system. Contaminated and clean condensate tanks of 500,000 gal are provided.

6. Prepare demineralized water

BREED FEEDWATER SPECIFICATIONS

Total Dissolved Solids	150 ppb max
Silica, SiO_2	20 ppb max
Iron	10 ppb max
Copper	5 ppb max
Dissolved Oxygen	7 ppb max
pH control by NH_3	8.8 to 9.1
Hydrazine feed, N_2H_4	20 ppb

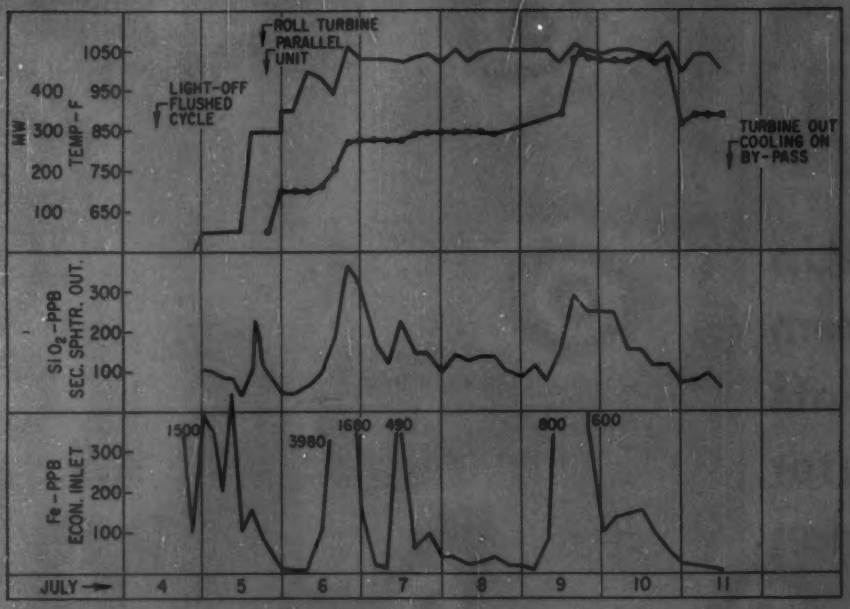

FIG 2—FIRST FULL-LOAD run shows that silica and iron peaks are caused by major load increases and rapidly subside to normal values

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from Zeolite softened river water for initial start-up only, since no evaporator operation was possible until the unit was in service.

The clean-up system consists of four filters, operated in pairs, and three mixed-bed demineralizers. The demineralizers operate at conventional flow rates for a maximum of 675,000 lb per hr. This corresponds to about 33% of full-load condensate flow and more than 60% of start-up flow. The demineralizers may only be operated with prefiltration.

Filters with 250 sq ft each of surface area are of the wire-wound tubular element type. At a filtration rate of 4 gpm per sq ft, they provide 100% filtration at full load. A purified cellulose fibre of nominal 100 mesh size is used as the coating material on the 5 ft-9 in.-long elements. Tests of a single full-sized element in a glass column demonstrated uniformity of coating of the filter aid and its removal by backwashing. This effectiveness is due to a properly designed center tube distributor in each element of the filter.

Previous to commercial operation, each of the three demineralizers had been regenerated more than 100 times. Most of these regenerations were for make-up production where runs of only one-hr duration were possible because of high solids in the influent water supply. In terms of regeneration frequency, this is equivalent to almost ten years of normal service.

Filter runs for this same period totaled almost 300 per pair, mostly for condensate clean-up. This is a frequency of about four re-coatings per operating day during a six-month period when clean-up recirculation and operation was less than 50% of the total time. Presently, filter runs of 1 to 3 days are obtained.

Cleaned With Acid

Pre-operational chemical cleanings were carried out in three steps:

1. Reheaters with 3% citric acid —a volume of 110,000 gal.

2. A condensate-feedwater cycle, excluding condensers, with an alkaline phosphate solution followed by 5% hydrochloric acid—a volume of 80,000 gal.

3. Steam generator with 3% citric acid—a volume of 70,000 gal.

These phases were very complex in detail and planning, and required 114 pages of text, valve lists and sketches on cleaning instructions.

Originally, instructions for the steam generator cleaning called for draining acid, and subsequent rinse fills to conserve water. Unfortunately, extreme cold weather froze the drain lines, and a 24-hr period was required to complete drainage of the acid. Chemical analyses of the rinses showed that a satisfactory cleaning job had been done, and the steam generator was then stored under nitrogen for two weeks.

Iron Content Rises

When cold recirculation was started for cycle water clean-up, iron content was as high as 30 ppm. Even after several displacements of water to waste, the iron content, at 250F, rose to 200 ppm. In addition, a yellow color, caused by an iron citrate complex, passed through the filters and demineralizers. This iron citrate was formed by the baking-on effect of residual acid film on the hot metal surfaces—a characteristic not previously encountered with citric acid. The steam generator was cleaned a second time by the normal procedure with no resulting bad effects during a two-week outage.

There were 19 start-ups from early February until June 21, when the unit was first paralleled. These periods of recirculation were of short duration, with varying periods between start-up and shut-down. Because of this, little actual clean-up and stabilization of the iron oxide content was done until early July. Iron content at the start of each re-

circulation period ranged from 1 to 9 ppm, and depended on the length of outage as well as other factors.

When the unit was first paralleled, the initial steam flow through the reheaters caused the condensate to become dark brown with suspended rust. This was expected since the reheaters had been cleaned with acid six months before and had been blanketed only partially with nitrogen. Filters plugged immediately. It was not possible to displace condensate flow at this time because of water shortage. It so happened that the unit tripped within 35 min so this wave of contamination did not reach the steam generator.

Silica and iron values for the first full-load run are shown in Fig 2. This run was preceded by a seven-day outage. Three previous starts of 25 to 35 min each had been made, up to 50 Mw.

Iron Peaks With Load

Peak amounts of iron were caused by each major load increase and by initial service of high pressure heaters and feed pump condenser. But in all cases, the iron content rapidly subsided to normal values. Dissolved solids for the run shown on Fig 2 are:

Start recirculation	**350 ppb**
Peaked when unit paralleled	**700 ppb**
24 hrs later to end of run	**150 ppb**
Cooling to 650F at end of run	**500 ppb**

This cooling period was the one instance when washing of soluble salts from the steam generator has been demonstrated. Subsequently, normal values of dissolved solids have gradually decreased to 75 ppb or lower.

The Breed unit has shown that iron oxide passes through the steam generator without depositing as long as outlet temperature does not exceed 500 to 550F. Distinct deposition of almost all the entering iron oxide results at 600F and above.

Knowing that changes such as increased flow or temperature result in increased iron oxide in the feedwater, the question arises—Is it better to deposit a little iron oxide over a long period or a lot of iron oxide over a short period before paralleling the unit? Obviously and within reason, the latter applies

A modified practice permitting more rapid starts has been adopted recently. Recirculation through the by-pass system is started without filtration and demineralization, and steam generator outlet temperature is raised to 500F. Condenser vacuum and deaeration are established as soon as flash tank conditions permit steam sealing the turbine and sufficient flow to the deaerator. Then, demineralized water from clean condensate storage is used to displace an entire cycle volume to contaminated storage. Filters and demineralizers are placed in service, and the temperature raised to 600F. When the iron content has decreased to 50 ppb, the temperature is raised to 850F, the turbine is rolled, and the unit loaded.

Fig 3 shows the iron concentration for a recent start, following an eight-day outage. It has repeatedly been demonstrated that the displacement flush at elevated temperature takes less time to reduce iron to acceptable levels than short-run filtration cycles from the beginning of recirculation. This flush water is not wasted, but reclaimed by polishing at a more convenient time.

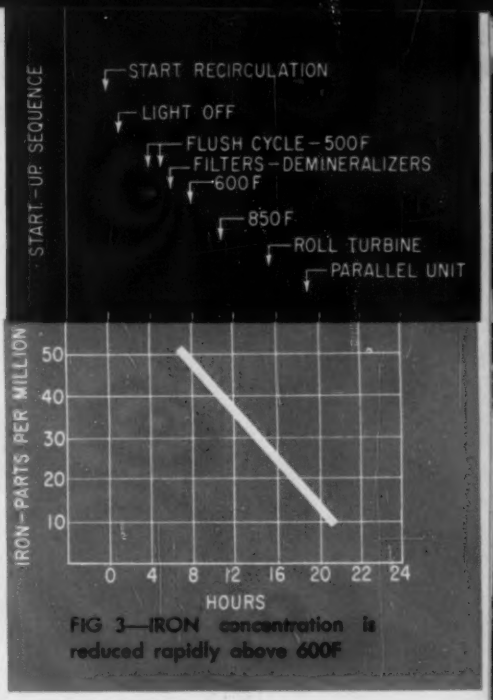


FIG 3—IRON concentration is reduced rapidly above 600F

High Silica Found

Silica, excessively high during the early start-ups, was about 100 ppb despite demineralization of 60% of condensate flow. Debris on the auxiliary feed pump strainer consisted of about 10% of sand; one-half gal of loose material in a condenser hot well consisted of more than 30% sand. The source of this sand was the condensers, which had been sandblasted and painted prior to tubing. Some of the sand had become embedded in the paint film and was gradually being dislodged.

It was finally necessary to parallel the unit at a silica concentration of about 100 ppm in the steam. This appeared to be the equilibrium condition between silica being dissolved and that removed by demineralization.

Fig 2 shows silica peaks coinciding with iron peaks with about a 100 ppb level for normal operation. Since then, silica has been gradually reduced to a 2 to 10 ppb level. It continues to peak for a short time, however, for each start-up, to about 50 to 100 ppb, depending on the length of the outage.

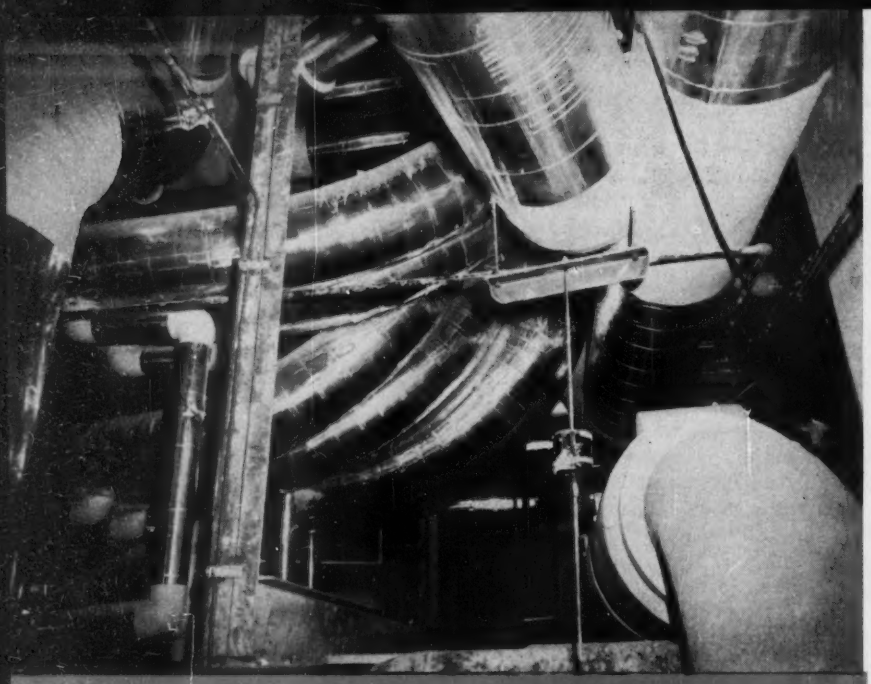
Operation of the Breed unit has demonstrated the need for stringent design considerations to prevent condensate feedwater cycle contamination. Not only must operating errors be prevented, but design of the system must guarantee freedom of contanimation by other water sources.

Must Maintain Quality

Several experiences at Breed aptly point up the need for designing out contamination. All of them required not only difficult detection, but well planned correction. For example, evaporator preheater vents, conducted to a vent stack, returned to the condensate instead of to waste. Also, an alternate evaporator vapor line to a low pressure heater gave problems because of valve leakage.

As an initial design consideration, an automatic valve controlled by a conductivity cell protects the condensate against accidental admission of demineralizer regenerants. Protection is also furnished against an improperly rinsed demineralizer being placed in service.

To date, the amount of copper in the steam has been well below the 5 ppb specified maximum. For normal operation, the amount of copper is about 1 to 4 ppb. There is a consistent trend of deposition of copper across the steam generator. Whether this deposition will finally reach an equilibrium remains to be seen.



CLOSE QUARTERS in some instances at Breed made clearance for expansion an important factor. Shown is piping under the high pressure turbine

Piping Design Integrates Factors of Size, Stress And Material

Reliability and economy are objectives in design involving wide range of site conditions

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■ The piping system for the 500-Mw Breed unit has been designed for pressures ranging from 4,600 psi to vacuum, and temperatures from 1,050F to 32F. The design involved long pipe runs through high, open spaces as well as others in close quarters where clearance for pipe expansion was an important factor. Moreover it involved the study, review and restudy of the economics of pipe size, stress, material and erection. How these factors were integrated into the design and layout of the Breed unit is told on these pages. Objectives throughout were good design with reliability and economy.

Piping Design Developed in Steps

Main steam piping was developed in several stages as the arrangement of the superheater outlet header was resolved. Because it is positioned under the reheat outlets, the superheater outlet header had to be close to the boiler. And because of expansion considerations it had to be divided into four sections. Outlet headers were hung from the boiler wall. This limited the reaction they could accept and this in turn made combining pipes, or joining them in a mixing header complicated because of possible temperature variations across the superheater. However, since there are four main turbine stop valves and the temperature variations could be held to the turbine limitation, four pipes turned out to be the economical solution.

Use of a pipe of 14 in. OD and 7½ in. ID made of 2¼% chromium—1% molybdenum P-22 material resulted in a pressure drop of 122 psi, with a steam velocity of 10,000 fpm. Moreover, this size provided adequate flexibility and allowable reactions using the routing shown in the accompanying drawing. Because of the diameter-to-thickness ratio, forged and bored material was the only type available. Fortunately it could be obtained in 30-ft lengths which offset its high cost.

Stainless steel, with its higher allowable stress and smaller permissible pipe sizes, was ruled out by the fact of having eight dissimilar welds and the possibility of problems associated with stainless welds. Moreover, since the pipe routing was already as direct as it could be, using FP-22 material, the cost of stainless pipe was unattractive.

It was possible to anchor the stop valve header in a fixed position because of the flexible leads between the stop valves and the control valve chests and turbine shell. Rigid supports were located in each of the main steam risers fixing location of pipes for all expansion movements. The resulting moderate stress eliminated need for any cold pull.

Initial tests of the steam generator showed that the wide variation in steam density, in the 710-730F temperature range, affected flow in the main steam pipes. This problem is described in detail in the steam generator article (p 50). To solve the problem and assure uniform temperature in all four pipes, a resistance orifice and a cross-tie upstream of this orifice was installed to a point downstream of the orifice on each other pipe. This complicated the piping arrangement close to the outlet headers, but it involved the smallest pressure drop in the system and permitted the shortest procurement and erection time. The piping arrangement has performed without problems since this modification. Under all conditions of flow of both water and steam the line has operated quietly, and both steam flows and temperatures have been equalized.

The first hot-reheat steam system resolved itself into a single pipe with the help of a single reheat outlet header that had a large enough diameter to use a single outlet connection. The route length between the

outlet header and the turbine was also long enough to give the resulting large pipe satisfactory end reactions.

This pipe is 26-in. OD and has a 2¼-in. minimum wall of hollow-forged A-335-P-22 material and carries 950 psi, 1,050F steam at a velocity of 16,200 fpm with 30 psi pressure drop. The single line splits through a lateral connection to supply two stop valves. This arrangement provides the least possible pressure change as the reheat stop and intercept valves are closed individually for testing while the turbine is operating. Since the temperature of the HP turbine exhaust (cold first reheat) was only 725F, carbon steel pipe was used. With this material it was economically possible to permit use of two large diameter pipes, resulting in low velocity and low pressure drop. These pipes were 24-in. OD with 1¼-in. wall and carried the 1,035 psi steam at 6,900 fpm with a 10.3-psi pressure drop.

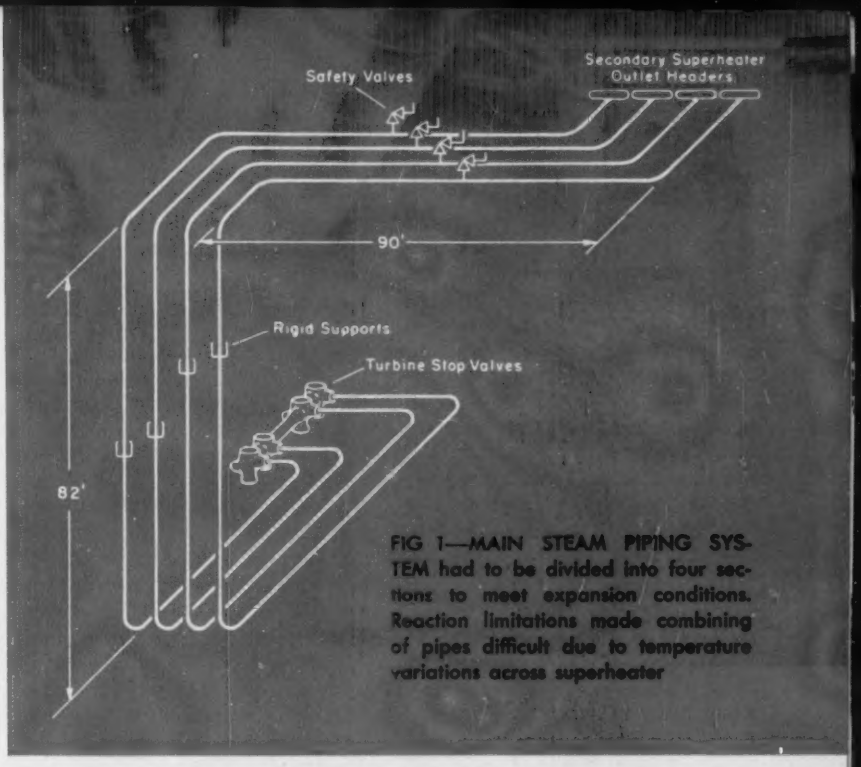

FIG 1—MAIN STEAM PIPING SYSTEM had to be divided into four sections to meet expansion conditions. Reaction limitations made combining of pipes difficult due to temperature variations across superheater

The second reheat steam system originates at two outlet headers in each of which steam is mixed through an alternate tube arrangement. The steam then travels to each of the second-reheat turbines through a pipe from each header. Each of these pipes splits near the turbine to supply two reheat stop valves. The most economical pipe for the 1,050F, 300 psi steam was 30-in. dia with 1½-in. wall. Material was 1½% chrome, ½% molybdenum (P-11) material in the form of rolled and welded plate pipe to specification A-155.

The reheat steam systems also use a rigid support in the riser to fix pipe elevation. Constant support springs were used to reduce load variations where large movement was encountered. Variable support springs and rigid supports were used wherever calculated pipe movements permitted.

Supports on the cold reheat steam lines were subjected to what might be termed a "shakedown test," when the turbines were first rolled. The 1½-in. drains had clogged during the clean-up cycle and a sizable leg of water was standing in each pipe when steam was admitted to the turbine. The heavy banging that resulted was immediately felt in the control room above and the unit was tripped. Lines were drained before steam was admitted to the turbine again. No damage was suffered.

The feedwater system consists of the low-pressure section from the discharge of the LP feed pumps through heaters No. 6 and 7 to the section of the main feed pumps, and the HP feed section which extends from the main feed pumps to parallel streams through the HP heaters to the economizer inlet header. Pipe in the LP section, operating at 600 psi, is ½-in. average wall carbon steel with main flow handled in a 16-in. pipe at 14 fps.

The 50-ft riser from heater No. 7 and the horizontal runover to the high-pressure pumps were subjected to movement due to pulsating flows, or pressure conditions set up by the pumps at certain operating speeds. This movement became so violent that pump operating procedures had to be set up to avoid particular speeds or pass through them quickly. It was not possible to restrain the piping under this pulsation because high pipe reactions would in turn be imposed on the pump. Spring type snubbers were used as well as guides which prevented movement other than that required for expansion.

The high-pressure feedwater system starts as an 18-in. OD hollow forged pipe with 2½-in. average wall, made of Grade C carbon steel. Where it divides into two streams through each pair of heaters, 14-in. pipe with 2-in. average wall is used made of A-106 Grade C carbon steel. Velocity in the 18-in. pipe is 18 fps and 15 fps in the 14-in. pipe under normal conditions. With one set of heaters out of service and full flow through the other, the velocity in the 14-in. pipe doubles. This system operated very smoothly, even during periods when the suction piping was vibrating severely.

The feedwater shut-off valves at the economizer inlet header play a dual role in this design as they are also the high-pressure heater outlet valves. The feedwater system valving was simplified because feedwater control is accomplished entirely by feed pump speed control.

The by-pass system is peculiar to the once-through type of unit. It originates with the superheater bypass valves at the front and rear near the top of the steam generator and continues down to the basement flash tank which also receives water and steam from the turbine bypass valves. In effect this tank is a small steam drum which drains *water* from the bottom to drain valves at the condensers, and *steam* to the top to pressure regulating valves at

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the unit's main steam condensers.

The flash system requires careful design because it must function over a pressure range from 0 to 1,000 psi. It is subject to the shocks of quick-opening valves which discharge either high-pressure water or steam, or a flashing mixture of both. Pressure variation is critical in the design of the flash tank vent and drain valves. One of the first problems encountered due to pressure variation was the inability of the tank to drain when there was low pressure in the system. This caused flooding of the tank and many of the long horizontal runs leading away from it. As pressure was raised and steam developed, water hammer shook the system in a number of locations where the water did not drain away quickly enough. This was overcome by pegging the system with air at a pressure high enough to provide adequate flow through the flash tank drain valves.

The flash tank drain line is a 10-in. Schedule-100 pipe handling velocities up to 7 fps. It is long and had to be restrained with struts and spring snubbers when variable flows caused excessive pipe movement. Reducing the size of two of the four drain valve plugs smoothed the flow. Here again need for flexibility to accommodate expansion clashed with the desire to tie down the line against the forces imposed by varying flow conditions. But again the only safe way to solve the pipe movement problem was to seek out the source and eliminate it.

Flash tank vents are 8-in. Schedule-100 pipes leading to control valves at each condenser. This piping was set in motion near the control valves by high frequency originating in the valves. Such vibration is characteristic of pressure reducing valves covering this pressure range but is tolerable for the short periods that they operate during startup.

Both the steam and the water enter the condenser through perforated spray pipes that distribute it over a wide area in the condenser and insure proper cooling during operation of the by-pass system, when the turbines are not in service.

The flash tank is the source of steam for the deaerator, the highest stage feedwater heaters and the turbine seals during start-up. These lines were designed for the 1,000-psi flash-tank pressure and were provided with adequate slope for drainage since they carry saturated steam most of the time.

The condensate system is more elaborate on the once-through cycle because of the need for high purity water. Although the condenser tubes were welded to the tube sheets, the hotwell was divided in two and provisions made for sampling condensate from each of the drain connections. If the sampling indicates possible tube leakages in a segment of the condenser, this water can be pumped through the condenser drain pump back to the contaminated storage tank. From there it can be taken to the demineralizers and returned to the cycle or to clean condensate storage. This requires a double set of piping in the condensate hotwell area to provide for this drain flexibility. The capacity of the demineralizers was also based on handling the flow from one-half of a condenser over a period of time so that the unit would not have to be shut down immediately because of a condenser tube leak.

That portion of the condensate system in which water is always flowing is carbon steel. The clean condensate storage tank and piping from it to the condensate system where water may stand for periods of time are of stainless Type 304 material. The demineralized water is corrosive to carbon steel and it is undesirable to have it picking up iron in the storage tank and condensate return systems while waiting to be returned to the cycle. Schedule-10 stainless was used in all sizes.

The other addition to the condensate system was the condensate by-pass pumps and piping. These pumps take their suction from the discharge of the hotwell pumps and in turn discharge to the filters upstream of the demineralizers. Under this arrangement all or part of the condensate flow can be taken through the filters during the clean-up period accompanying each startup.

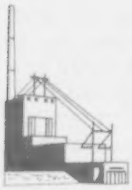
Two closed cooling water cycles are provided on this unit. The turbine auxiliary cooling water cycle provides large quantities of water for hydrogen cooler, the stator oil coolers, the turbine oil coolers and turbine seal leakoff condenser. This cycle gives up its heat through a heat exchanger to the condensate system when condensate temperatures are low, and through a second heat exchanger to the circulating water system when condensate temperatures are high. Having a separate cycle for this service precludes the possibility of the main condensate stream becoming contaminated with oil. Standard carbon steel pipe is used for this system. The second cycle provides smaller quantities of cooling water fan bearings, pump-oil coolers, water-cooled doors on the steam generator, air compressor cylinders and cooler, intercoolers on the vacuum pumps, and the feed-pump oil coolers and injection water cooler. The heat from this system is given up to the circulating water through a heat exchanger. Type "K" copper tubing is used for smaller lines to avoid corrosion product buildup.

It was not possible to blow out steam lines as was done on conventional units because the quantity of steam available from the flash tank was too small to provide effective velocities in the large pipes.

Care Taken in Cleaning

Special care was taken to insure that all pipes were clean as they were erected. In a number of cases this involved power brushing where a section of pipe had accumulated dirt or rust during the storage period following fabrication. Each pipe section was inspected again prior to weld fitup to double-check on cleanliness. Final cleaning was done by water flushing and circulating hot acid. The same method was followed in the condensate-feedwater piping. The main steam pipes were very adequately cleaned by the water and steam flows they carried during the cycle clean-up period.

Welding of the main-steam, first-reheat and high-pressure feed system was done using an inert-arc, root-pass method, with a consumable insert ring. The remainder of the weld was made by the metal arc process using Type XX18 electrodes. On both the main-steam and first-reheat system, the root weld and the finish weld were inspected by gamma-ray.



Size and Location Require Unique Switching and Transmission Systems

Stability and overvoltages call for shunt reactors, high exciter response ratio, switching station, and careful operating setup

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FIG 1—BREED generates at mine mouth and transmits to load center at South Bend over a 186-mile, double-circuit, EHV steel tower line

The decision to locate a major generating plant near Terre Haute, Indiana, 186 miles from the service areas of the Indiana & Michigan Electric Company, presented new and challenging problems in planning, design and operation on the American Electric Power System. The unique features of Breed Plant from an electrical standpoint are its remoteness from the remainder of the high-voltage transmission system and the concentration of about 500 Mw of generation in a single generating unit, more than twice the size of the most modern existing machines in operation on the AEP System. The broad objective was, therefore, to tie the plant most economically into the bulk transmission system and still meet reliability criteria commensurate with the size of the unit. In addition, the necessarily larger electrical components, as well as the size of auxiliary load, called for a re-evaluation of past practices in plant layout and design of auxiliary equipment.

Fig 1 shows the relationship of Breed Plant to the remainder of the I&M System, while Fig 2 is a simplified one-line representation of the transmission and switching facilities associated with the plant. Since South Bend is a major load growth area and also represents the western terminus of the AEP System, it was decided to tie Breed Plant into the system at the Olive 345-138-kv station at New Carlisle, Indiana, about 12 miles west of South Bend.

An evaluation of alternative transmission plans led to the decision to build a double-circuit, steel-tower, 345-kv line from Breed to Olive, with one 1,414-MCM, 1.75-in. expanded ACSR conductor per phase and two 159-MCM ACSR ground wires. Two 345-kv circuits were considered minimum in order to provide the necessary transmission capability as well as operating reliability. To assure this transmission capability as well as adequate transient stability margins during a single-circuit outage contingency, the Dequine intermediate switching station was located about midway between Breed Plant and Olive Station. This switching station, al-

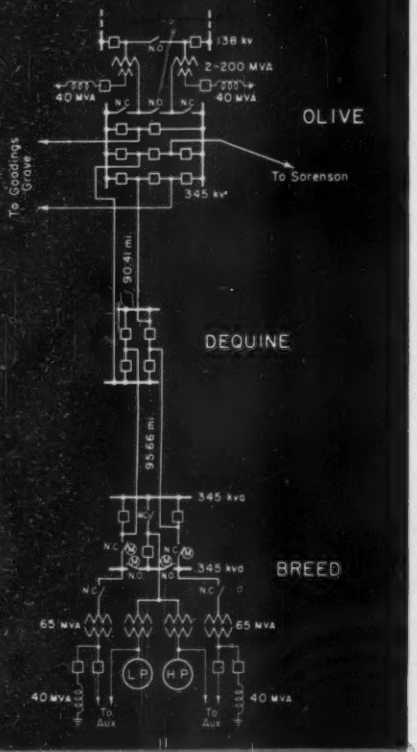

FIG 2—REACTORS and switching setup help solve overvoltages

BREED PLANT

though initially equipped with four 345-kv circuit breakers, can be expanded to a one-and-one-half breaker scheme when additional circuits are added. Similarly at Breed Plant, the switching can be expanded to a one-and-one-half breaker plan.

Two 40-Mva blocks of shunt reactors are located on the 13.8-kv tertiaries of the 65-Mva auxiliary reserve transformer at Breed Plant. They provide necessary lagging reactive to hold down 60-cycle dynamic overvoltages in the event of load rejection, to increase steady state and transient stability margins, and to reduce the possibility of dangerously high voltages, currents and motor-braking torques during unit start-up or maintenance periods.

Large, 3-phase power transformers provide generally long, trouble-free life. However, the large investment in a 500-Mw unit and the serious consequences, economic and otherwise, of having a large, highly efficient generating unit out of service for an extended period discouraged specification of a single 550-Mva, three-phase, 345-16.5-kv power transformer for the main step-up bank. Rather, two 275-Mva transformers, each provided with an external surface water-cooling system to allow either to carry continuously 450 Mva, were used.

Operable on One Transformer

The generator bus is of the isolated-phase design rated 11,000 amp, self-cooled, and insulated to withstand 80-kv, 60-cps dry and 70-kv dew test. There is a 5,500-amp tie bus which connects the generators together to one transformer if the other transformer should be taken out of service. Under such a contingency it is planned to carry 16,000 amp on sections of the 11,000-amp generator bus, with a calculated temperature rise of the bus conductor of 100C.

The total auxiliary connected load is 30 Mva, with a diversified demand of about 20 Mva. These figures do not include the auxiliary boiler feed pump motor.

Since many of the plant auxiliary functions are triadic, three 4-kv buses are provided. These buses are normally fed from 10/12 Mva OA/FA transformers connected to the generator leads, and backed up, in turn, by two 12/16 Mva, OA/FA, LTC reserve transformers. Load tapping was provided on the reserve transformer because of possible 10% variation in the level of the Breed 345-kv bus voltage. Two-cycle transfer from auxiliary to reserve transformer is provided by stored energy mechanisms in the reserve bus switchgear. Loss of an auxiliary 4-kv bus results in a 20 to 60% reduction in generation.

The selection of the plant auxiliary system was seriously affected by the 13,500-hp boiler feed pump motor which is used to start the unit and to obtain about 60% unit output when the turbine-driven feed pump is out of service.

Because of its large power requirement, the feed pump motor was separated from the rest of the auxiliary power system and supplied along with the coal-handling load from the 345-13.2-kv reserve transformers. To have integrated this large motor into the 4-kv auxiliary system would have resulted in a highly distorted and unbalanced system.

Liquid Rheostat Used

The drive for the boiler feed pump is a 13,500-hp, 13.2-kv, 70C-rise, Class B-insulated, 720-rpm, wound-rotor induction motor coupled to a step-up gear to provide a maximum pump speed of 3,500 rpm. Fine control of pump speed down to 1,750 rpm is obtained by a liquid rheostat connected in the rotor circuit. This drive was as economical in installed cost as any comparable variable speed drive of 2:1 speed range. Squirrel cage induction motor variable-speed coupling combinations in this horsepower range would have involved an excursion into virgin fields of motor and coupling design; whereas, much larger wound-rotor induction motors had previously been satisfactory on other types of applications. The wound-rotor motor with liquid rheostat eliminated any large starting kva requirement.

Automatic speed control was provided with an amplidyne control system sensing feedwater pressure. The amplidyne generator drives a pilot motor which controls the liquid rheostat electrode position. Sodium carbonate is the electrolyte along with a small amount of sodium chromate which is a rust inhibitor. Since the electrolyte has a negative temperature coefficient, automatic cooling water temperature control was provided.

All other auxiliary motors are squirrel cage induction motors, with the exception of the 600-hp, 400-rpm slag blower compressor motors. The latter are synchronous motors because of cost savings.

With few exceptions, the auxiliary motors are of drip-proof construction, with 40C rise, Class A insulation. Experience has indicated that the combination of drip-proof construction and Class A insulation is entirely adequate in most instances for power plant operations. Exceptions to the Class A-insulation specification are the 5,500-hp forced draft fan motors which are 70C rise, Class H insulated, and the gas recirculating fan motors which are 40C rise, Class B insulated. Since the loss of one of these fan motors results in a load curtailment, the more durable insulation was se-

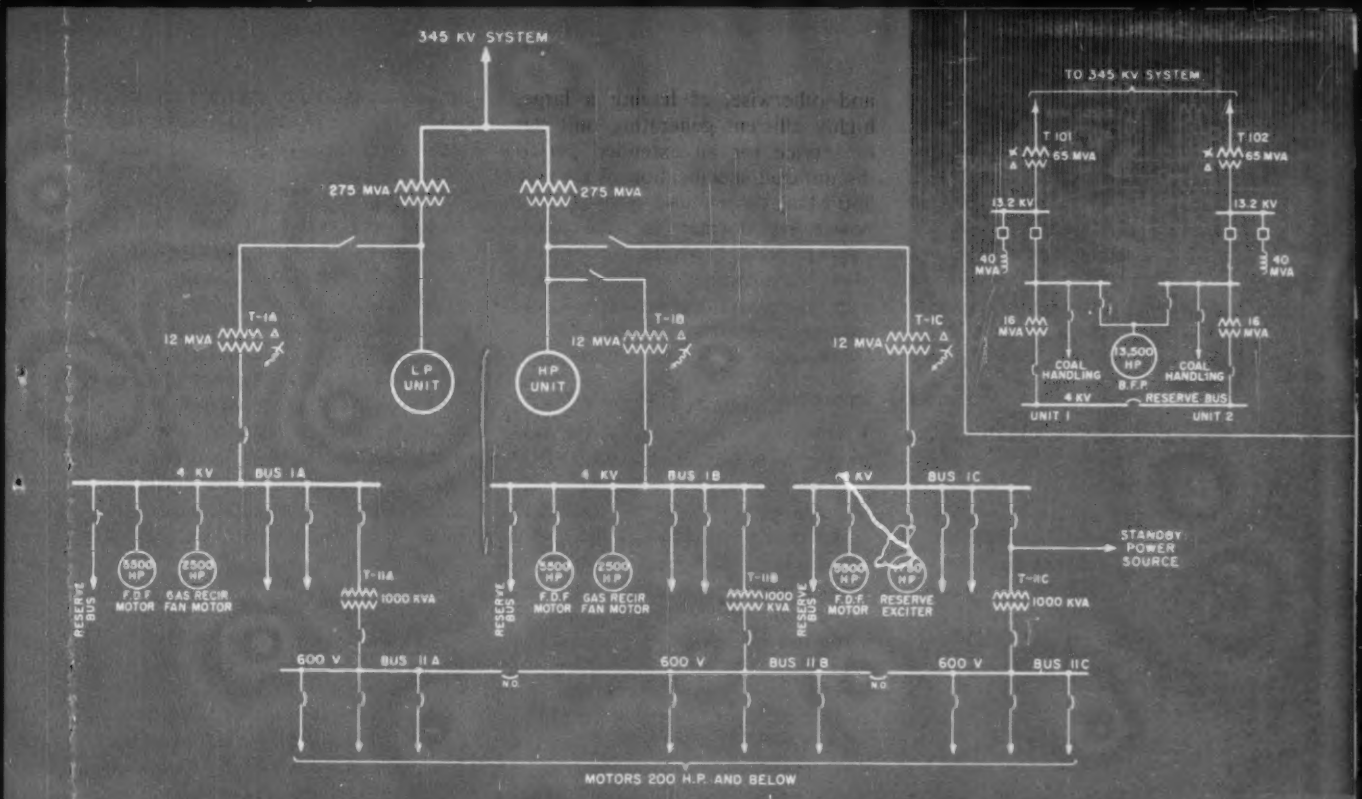

FIG 3—COAL HANDLING SYSTEM and 13,500-hp boiler feed pump supplied separately, allowing balanced, triadic 4-kv auxiliary system supplied by three 12-Mva transformers and backed-by two 16-Mva transformers

lected. These fan motors are also of drip-proof construction, with top discharge. The forced draft fan and gas recirculating fan motors are housed in transite enclosures with one louvered side. The motor exhaust air is ducted from the top of the motor through a non-louvered side of the enclosure. This type of enclosure proved to be more economical in installed cost than weather-protected motors, and eliminated the problem of recirculating motor exhaust air to the motor inlet air openings.

Two Batteries Needed

Because of the large size of this generating unit, it was decided not to rely on a single 250-v storage battery for the first unit, but rather to split the dc emergency lighting, valve, and emergency pump load on two plant batteries. The two plant batteries together are rated 938 amp-hr at an 8-hr rate, as compared to 320-amp-hr battery capacity for the batteries used on previous 225-Mva units. The larger rating was dictated by the increase in the size and quantity of the dc emergency equipment. These batteries are float-charged by selenium rectifiers, and all of the dc requirements can be supplied from one of the batteries in an emergency. A separate 250-v battery is installed in the control building in the switchyard.

There are certain critical auxiliary loads, such as pipe heating cables, battery chargers, sump pumps, fire pumps, and a minimum amount of standby lighting, which should be operable even under the improbable but still possible contingency of an extended outage of both 345-kv circuits. These loads, it will be recognized, are for preventing serious damage to the boiler equipment and to allow repair work to be carried out. All of these critical loads are connected to one of the 600-v fuses which can, if necessary, be supplied from a standby power feed from the local utility.

The comparatively low inertias and time constants of the Breed generators and the relatively long transmission distances between Breed Plant and the remainder of the AEP System made transient stability a major consideration. Studies indicated that even with a 50% reduction in the reactance of the generator step-up transformers, the critical switching time for a 3-phase fault on one of the Dequine circuits at Breed Plant would be only 4.4 cycles, based on standard 0.5 exciter response ratio. This would leave little, if any, margin for overall breaker clearing time of 4 cycles, premised on three-cycle breaker time and one-cycle relay time. For this reason the main exciters for the Breed Plant generators are designed for an exciter response ratio of 2.0 per unit, so as to provide a critical switching time of 5.5 cycles for 3-phase faults. Comparable critical switching times for double phase-to-ground faults at Breed were thereby increased from 5.5 to 6.6 cycles. Higher response excitation also reduces the overvoltages immediately following full-load rejection to within safe limits of equipment insulation.

Exciters Are Shaft-Driven

The main exciters for each generators are shaft-driven through reduction gears and are rated 1,250

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kw, 375 v, 603 rpm. The spare motor-driven exciter set has a response ratio of 1.0 since it will be used only for a short period during start-up and occasionally as a substitute for the shaft exciter on one of the two generators. On such occasions, the spare exciter is controlled by the rotating amplifier-type voltage regulator to assure that at all times the generators are under regulator control, thereby providing maximum benefit in maintaining stability.

Since there are no company-owned power supply facilities near the plant, the plant auxiliaries during unit maintenance and unit start-up must be supplied over the 186-mile, 345-kv transmission line from Olive to Breed. The opening of this line at either Olive or Dequine would place the inductances of the auxiliary motors and transformers in series with the charging capacitance of the 345-kv line. The circuit, when energized by the internal voltage of the rotating auxiliary motors, may cause a series resonance condition, resulting in high motor currents and high voltages on the 345-kv and motor buses. This condition would be further aggravated by the self-excitation of the motors, caused by the line-charging current of the 345-kv line.

BREED switching station, initially equipped with three 345-kv breakers, can be expanded to one-and-a-half breaker scheme as circuits are added

Studies and field tests indicated that voltages in excess of 620-kv rms, phase-to-phase, would occur under these conditions if both Breed-Olive lines, as well as both 40-Mva reactors, were in service at the time of the disturbance. The possibility of such dangerous conditions can be minimized by careful choice of the operating setup to be used during unit maintenance and start-up periods. After extensive studies it was concluded that the least hazardous operating setup would be to have one circuit in operation between Breed and Dequine and two circuits between Dequine and Olive, with two reactors in service at Breed.

High Voltages Can Occur

Overvoltages would occur on the Breed 345-kv bus in the event of load rejection due to accidental opening of both 345-kv circuits at Olive or Dequine. These overvoltages would be caused by excessive full-load field current which exists after load rejection, by heavy inflow of line-charging reactive power into the step-up transformer and the generator, as well as by generator overspeed resulting from loss of load. Studies indicated that the most severe load rejection over-voltages would occur if both 345-kv circuits would open at Olive. The use of 2.0 per unit exciter response ratio helped to keep these overvoltages within safe limits. The voltage at Breed 345-kv bus would reach a peak of 450 kv, phase-to-neutral crest immediately after switching, decrease to 370 kv in three or four cycles, and then climb to about 390 kv in 0.5-1.0 sec.

The insulation on the main step-up transformers and on the two 65-Mva start-up reserve power transformer is 1,050 BIL which is two steps below normal and in line with AEP insulation practice. These transformers are protected by 71% arresters.

Of some concern in the selection of the arrester rating were the short-time overvoltages due to load rejection. It was felt, however, that considering the beneficial effect of the high response exciters and the small probability of a double-circuit outage, it was reasonable to accept the small likelihood of arrester failure, at least until additional circuits are taken out of the plant.

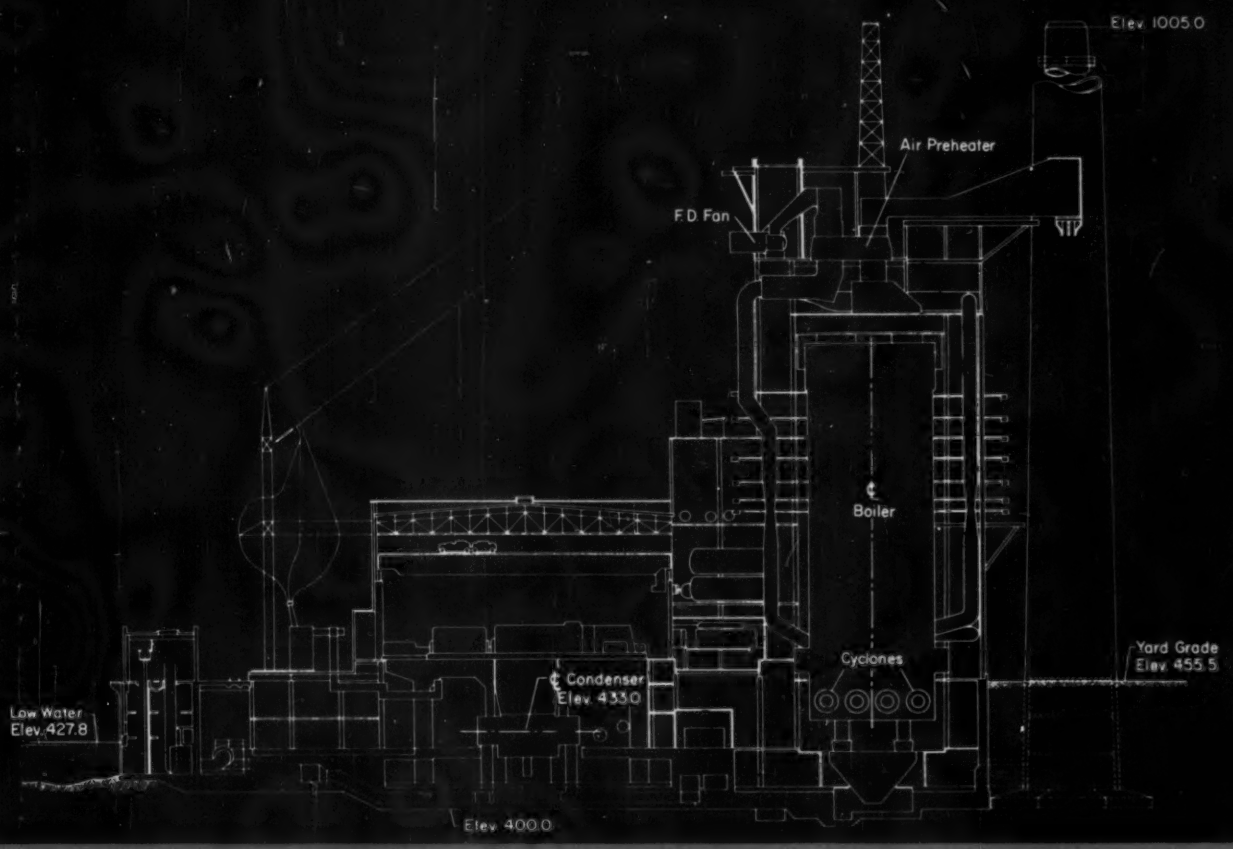
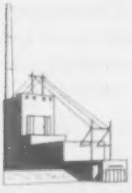


FIG 1—LONGITUDINAL SECTION through plant turbine room is enclosed, boiler and bunker areas outdoor. Operating floor of plant is protected against flood to 458 ft. Flyash concrete was used extensively in plant construction

Semi-Outdoor Structure Houses 500 Mw Compactly



Plant enclosed in 13 cu ft per kw. 550-ft concrete stack has four floor storage area at the bottom

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E. A. KAMMER, Head, Design Div, American Electric Power Service Corp, New York

■ Ground was broken for the Breed Plant late in 1956 at its site on the left bank of the Wabash River only about 20 miles southwest of Terre Haute. Slightly more than three years and nine months later the 500-Mw single-boiler-turbine plant, shown in the accompanying section drawings, was placed in commercial operation on July 31, 1960.

Superstructure of the plant is of the semi-outdoor type. The turbine room is enclosed with a masonry wall backed up on the inside with glazed brick. The heater bay is also enclosed, but with uninsulated transite. Boiler and bunker areas are outdoors but enclosures of the same material were provided around the forced draft fans and the tripper floor above the bunkers.

Operating floor of the plant is at elevation 456.0. It is protected by removable steel bulkheads to permit operation with a maximum flood of 458.0 ft. The maximum high water experienced at the plant site occurred in May 1943 and reached an elevation of 455.0 ft.

Because of the capacity of the turbine-generator unit, all pertinent equipment is physically large and, indeed, the general appearance of the plant is huge. As an example, the fan floor is approximately 180 ft above grade while the plant cubage, exclusive of office building, is 6,652,000 cu ft. This represents a unit volume of only 13.3 cu ft per kw however.

The stack serving the unit is of reinforced concrete construction and is 597.0 ft high above the base, 550 ft above grade. It was designed in accordance with ACI Code 505-54. The mix for the concrete footing of the stack was the same as that for the plant proper. The concrete for the stack shell, however, had a mix with a minimum design strength of 4,000 psi. It contained 6½ sacks of cement, 1,170 lb natural sand, 2,135 lb crushed stone and 260 lb of water per cubic yard. The 28-day strength averaged

BREED PLANT

4,370 psi. The stack is topped with a stainless steel Type 316 cap.

Inside surface of the concrete stack shell was coated with an asphaltic base inert mineral filler mastic. A 2-in. thick fused silica glass block laid in acid-proof mortar was placed against the mastic. A space of ½ in. was left between the glass block and the acid-proof brick lining for expansion.

Four floors are provided in the bottom of the stack for storage purposes. The upper floor of the stack is at the yard grade and the bottom floor at boiler room sub-basement level. A tunnel connects the plant sub-basement with the bottom floor of the stack. As the stack is considerable distance from any of the air lanes, no lighting or marking was required by the CAA.

Plant Burns 10,100 Btu Coal

Breed Plant burns bituminous coal supplied from the new Thunderbird Mine of the Thunderbird Collieries Corp as subsidiary of Ayreshire Collieries Corp. It is delivered to the plant over a 10-mile railroad, owned and operated by Thunderbird Collieries. The mine property contains three coal seams having more than 100 million tons of recoverable coal. These are the Indiana No. 6, 5, and 3 seams. The mine is underground, has conventional equipment and initially operates on the No. 6 seam. The coal is crushed and washed to a 1¼-in. top size. Coal averages 11,100 Btu per lb.

The coal supply agreement between the utility and the Thunderbird is for a 15-year period. The utility has the right to extend the term for an additional 15 year period. The colliery will furnish the entire requirement for three units.

Coal is unloaded for the initial unit on a one-shift, 5-day-per-week basis, with the mine delivering on two shifts, 5 days per week. Fourteen 70-ton gondola car trains transport coal from the preparation plant to the power plant. Track facilities capable of storing 70 full and 40 empty cars have been provided. One 80-ton diesel electric locomotive is used for shifting cars in and out of a rotary railroad car dumper, and a 25-ton diesel electric locomotive originally used for construction is retained by the plant for emergency standby.

Cars are unloaded in a rotary car dumper capable of handling 90-ton capacity coal cars on a dumping cycle of 1 min. The dumper has an electronic load cell scale mounted under the dumper platen which automatically registers gross and tare weight of each car as it enters and leaves the dumper. This data is recorded on a tape for all cars unloaded and provides a ready record of the coal unloaded. The weighing operation is under the control of the car dumper operator, thereby eliminating a weigh-master and reducing the shifting time that would be required if a separate scale structure were installed.

The coal being unloaded is independent of the coal flow to the plant bunker. This is made possible by use of a lowering well, a standard feature of recent AEP plants. Conveyors between unloading hopper and the lowering-well surge piles have a present nominal capacity of 1,050 tons per hour. When plant expansion necessitates additional capacity, the presently installed 42-in. wide belts will be replaced with 48-in. belts to match the 48-in. belt idlers initially installed. This increase in belt width will provide for a nominal capacity of 1,400 tons per hour and actually can handle 1,800 tons per hours. A swing conveyor is provided to place coal in the east end of the coal storage area, which is designed to store ultimately 1.6 million tons.

Coal Sampling is Automatic

Automatic coal sampling is provided between the dumper and the lowering-well surge pile. A coal sample is collected daily and used for determining quality specifications and purchase price of coal receipts. A belt scale is also provided to determine the amount of storage coal reclaimed through the car dumper hopper; the latter has been designed for handling coal pushed in by crawler tractor equipment. The feeder and conveyors from the rotary car dumper to the lowering well are controlled remotely from a panel located in a

FIG 2—PLOT PLAN of Breed site on left bank of Wabash River provides ample area for expansion for two future units. Captive railroad brings in coal from mine 10 miles away

control house adjacent to the unloading hopper.

The lowering well at the surge pile provides for filling bunkers from the storage area independent of the unloading operation. It consists of a vertical standpipe 6 ft dia and 135 ft high, with openings arranged opposite each other along its length so that coal can flow through them to form a conical pile. This 25,000-ton conical pile plus coal in the 5,500-ton bunkers provides ample storage to last from Friday afternoon filling until Monday morning, even for a third unit. Coal that flows from this pile is transported by a 36-in. conveyor to a crushed to 95% passing through a ¼-in. screen by two hammermill type reversible crushers rated at 600 tons per hour and driven by 1,250-hp motors. Operation is automatic; the controls are mounted on a special coal handling panel in the main control room.

The boiler is arranged so that dual 2,750-ton coal bunkers are provided on opposite sides of the boiler. The coal is distributed with 36-in. conveyors through three fixed points over each bunker. The amount of coal filled in these bunkers is automatically controlled by high level probes which are located in the bunkers proper. Upon completion of full cycle, the system from the surge pile is shut down. The panel board has lights which indicate the bunker being filled and shows when the bunker filling operation is complete. The operator can manually control any particular fill point in these bunkers.

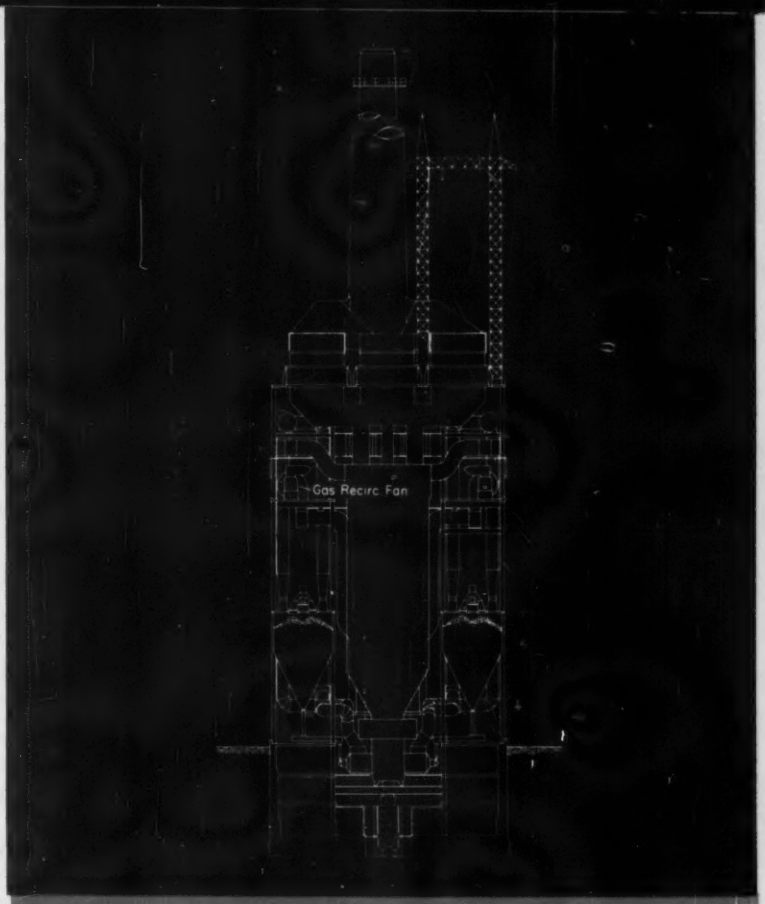


FIG 3—BOILER AND BUNKER areas of Breed Plant are outdoors. Transite enclosures surround forced draft fans and tripper floor above bunkers

How Coal is Stored

Coal is placed into storage with a swing conveyor. The coal handling system provides three points for reclaiming: At the rotary car dumper where the hopper has been designed to handle coal bulldozed into it; at another hopper below the lowering well; and at a third hopper above the conveyor leading from the lowering well to the bunkers. The latter is provided for reclaiming coal should the other two be out of service.

To spread the coal and reclaim from the pile, two crawler tractors have been provided for bulldozing into the reclaim hoppers and lowering well, or storing away from the swing conveyor. These tractors are equipped with special lightweight coal handling blades, 16 ft wide, 7 ft high, capable of bulldozing about 18 tons per pass. One rubber-tired carryall built up with 5-ft side extensions capable of hauling about 25 tons is used for hauls above 400 hundred ft. The storage yard is laid out for about 100 days' storage for three units.

The existing ground surface in the vicinity of the Breed Plant was originally at about 443.0-ft elevation. This was built up in the yard area near the plant to an elevation of 455.5 ft with fill excavated from the coal and ash storage areas.

In general the ground between elevation 443 and 428 consisted of sandy clay. Below 428 ft the material is generally firm, free-draining sand, which shows increasing compactness and content of gravel with increasing depth. Stratified rock consisting of shale, silt, stone and limestone was encountered in one of the borings about 2,000 ft landward of the plant (coal storage area), at 413 ft elevation. In the vicinity of the plant, some of the borings were carried to an elevation 375 ft and accordingly they were stopped in the sand and gravel strata. As the underside sub-basement founds at elevation approximately 400 ft, and the underlying sand and gravel stratum is a highly competent foundation material, the elevation of bedrock is in the vicinity of the plant and its characteristics were of no concern.

Cofferdam Was Needed

As the riverward face of the screen house was coincident with the low water line of the river, a cofferdam was necessary, at elevation 427.8 ft, to protect construction activities within the plant. An earth cofferdam built into the river was chosen for economic reasons. In view of the highly previous granular stratum which exists below elevation 428 ft, it was decided to perform a pumping test. A reasonably steady downfall condition was

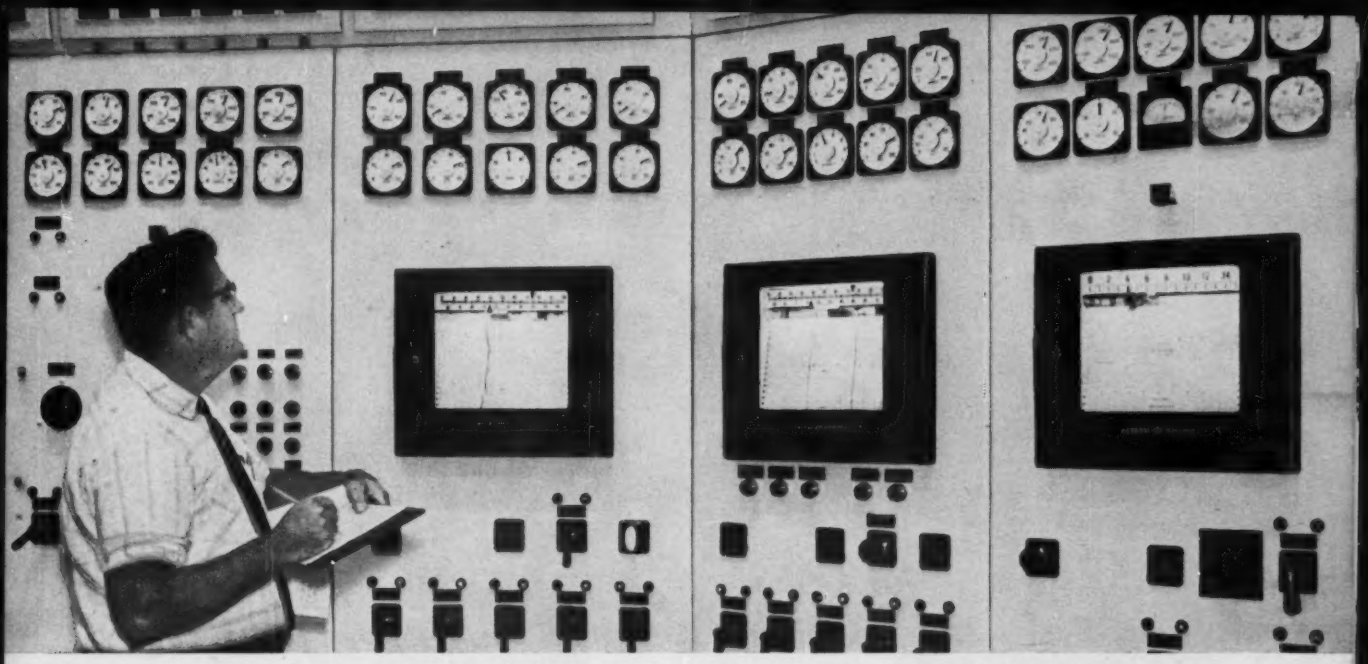
CONVEYOR carries coal to lowering well. Crawler tractors bulldoze coal into three reclaiming hoppers. Light blades 16 x 7 ft can bulldoze about 18 tons per pass. Yard has been laid out for 100 days' storage for three units

BREED PLANT

reached within 24 hours after start of pumping, with a pumping rate of 1,700 gpm using an 18-in. well. The drawdown curve showed a substantial drop between the river elevation and observation well close to the river, indicating that the river is lined with relatively impervious material.

It was therefore concluded that a steel-sheet pile wall, driven along the centerline of the entire earth cofferdam, could be installed to inhibit infiltration through the cofferdam. Straight web piling 50 ft long was used for this wall with the top at elevation 435 ft. Initially, the crest of the earth cofferdam was built to elevation 452 ft which is the 10-year frequency flood period. From the high river elevations occuring during 1957 it was thought that the 452-ft elevation might be exceeded during 1958 and it was decided to raise this elevation to 457 ft. This precaution was well taken for on June 17, 1958, a river elevation of 454.49 was attained but no abnormal leakage or flow came through the dyke. Three stages of wellpoints were employed in dewatering the hole, and the maximum rate of pumping was about 24,000 gpm during the greatest flood experienced during the construction period.

Concrete in the plant, coal handling and switchyard structures, etc., totaled approximately 67,000 cu yd. The bulk of this concrete other than the shell of the stack was placed with a mix consisting of three sacks of cement, 7,116 lb flyash, 1,000 lb normal sand, 2,590 lb of 1 and 2-in. gravel and 172 lb water per cu yd. The seven, 28, and 90-day strengths averaged 2,248, 3,896 and 4,757 psi respectively. Admixtures used in the mix were of the dispersing-agent and air-entraining types.

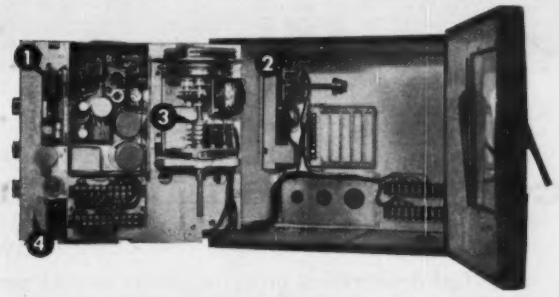


TYPICAL OF GENERAL ELECTRIC UTILITY INSTRUMENTATION is this bank of null-balance recorders and switchboard instruments at Florida Power Corporation, one of more than 80 utilities benefiting from the accuracy and reliability of G-E Recorders.

General Electric Recorder Reliability

Application-proved in Utility Systems Throughout the World

Today, more than ever before, utilities demand the greatest possible recording instrument reliability for monitoring electrical and physical parameters accurately. That is why General Electric, long established in quality instrumentation, offers you a *complete line* of null-balance recorders and recording controllers designed for accuracy, ease of calibration and dependable operation, to meet *all utility applications.* More than 80 foreign and domestic utilities depend upon reliable General Electric Recorders to accurately monitor parameters in central stations, substations and distribution systems.



In your central stations alone, General Electric "system engineers" the necessary instrumentation for your particular needs. This means your recorders, switchboard instruments and switchgear equipment are custom-designed in one coordinated "package" *at no additional cost* and delivered and installed *on time.* At Florida Power Corporation this "package" measures generator watts and vars, field and stator temperatures, turbine bearing temperatures and boiler-feed-pump motor temperatures.

With General Electric multi-point, single and two-pen strip and round chart recorders, *(all ¼% accuracy class, of course)* reliable performance begins on the *inside!* Here are four reasons why:

1. **Silicon diode reference source provides continuous standardization.**
2. **Multi-point selector switch permits remote location.**
3. **Up to 8 control switches; up to 4 transmitting slidewires easily accommodated.**
4. **All components mounted on swing-out panel for easy accessibility.**

GET THE FULL STORY on G.E.'s complete line of recorders and other utility instruments by contacting your nearest G-E Sales Office today; or write to Section 599-05, General Electric Co., Schenectady 5, N. Y., for your free, complete package of descriptive, utility-oriented literature. In Canada, contact Canadian General Electric Co., Limited, 940 Lansdowne Ave., Toronto 4, Ontario.

OTHER G-E INSTRUMENTS FOR ELECTRIC UTILITIES: Turbine Supervisory Instrumentation • Switchboard & Panel Instruments • Electric Recorders Automatic Dispatching Systems • High-Accuracy Portables • Vibration Indicators & Recorders • Hook-On Indicators & Recorders • Telemetering Systems

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

SPECIAL TUBING, under development as fuel element cladding, is filled with experimental nuclear fuel pellets in General Electric Fuel Development Laboratory.

URANIUM OXIDE POWDER is compressed into fuel elements through an experimental process of vibratory compaction.

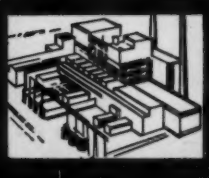
GENERAL ELECTRIC FUEL DEVELOPMENT PROGRAM AIMS TO . . .

Cut nuclear power costs one mill/kwh

A program of more than 35 separate research and development projects is now underway at General Electric to reduce the cost of nuclear fuel and thereby reduce total nuclear power generation cost. Improved fuels can cut nuclear power cost by 0.5 to 1 mill/kwh.

The fuel development program centers around continuing development of high performance, low cost nuclear fuels through reduced fabrication costs, longer fuel life, increased specific power, and the most economical fuel cycle possible.

General Electric
Boiling Water Reactor Technology
Helps Lower Nuclear Power Costs



NATURAL CIRCULATION

URANIUM ENRICHMENT ANALYZER, only one of its kind, is used for precision analysis of uranium compounds. Further development, including in-pile testing, is painstakingly conducted before production.

EXPERIMENTAL FUEL PELLET is weighed on the dust-free microbalance.

EXPERIMENTAL URANIUM OXIDE fuel pellets are removed from the high temperature sintering furnace. Stringent quality control is maintained from development to actual quantity production of nuclear fuel.

ENRICHMENT OF URANIUM compounds is determined by emission spectroscopy.

Primary emphasis is on better uranium oxide fuels for water reactors. Both in-pile and out-of-pile tests, to determine optimum fuel mix, are currently underway on cladding alloys, uranium compositions and densities, and element design prototypes.

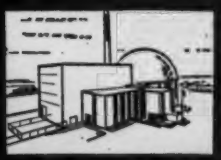
All phases of this fuel development program are being conducted at the same General Electric facility where complete nuclear reactor systems, instrumentation, control equipment, and other reactor components are developed, designed and manufactured.

For additional information on General Electric commercial atomic activities, contact your nearest G-E Sales Office or write to the General Electric Co., Section 132-10, Schenectady, N. Y. Outside the United States and Canada, contact International General Electric Company, 150 East 42nd St., New York, N. Y.

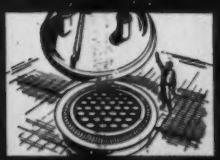
132-10

Progress Is Our Most Important Product

GENERAL ELECTRIC



HIGH POWER DENSITY



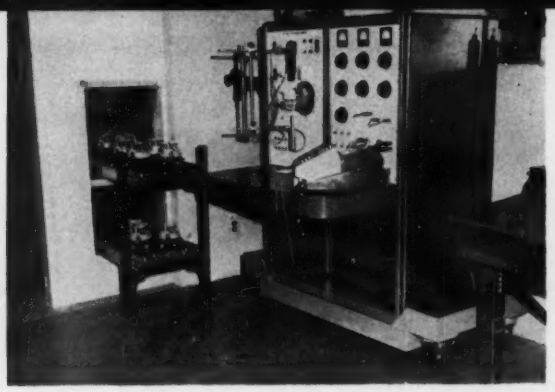
COMPACTING

NUCLEAR SUPERHEAT

ELECTRIC UTILITY METHODS

E u m

MAINTENANCE & REPAIRS



Dolly Plus Conveyor Solve Space Problem

A job-fabricated test-table dolly plus a simple but well planned conveyor system now allow Salt River Project Agricultural Improvement & Power Authority to test efficiently its polyphase meters despite the limited size of the available test room.

A newly acquired polyphase-meter test table by its nature required that its back be readily available for servicing. Space limitations in the test room precluded installation of the unit away from the wall. To solve this problem, Boyd Rogers, superintendent of the Meter Relay Division, had the project's machine shop construct a dolly on which the test table was mounted. With this arrangement, the test unit is placed against a wall during normal operations, yet can easily be moved forward for servicing.

Both the electrical cable and air hose connections to the test table are flexible enough to permit its free movement, without the necessity of disconnecting either.

A conveyor system, to move meters from the shop to the testing table, was arranged using two 10-ft sections of aluminum roller conveyor. These sections are supported by unistrut rails and floor flanges, with a cross bar at each support. The incoming conveyor is set to slop from the repair room to the testing section, with its lower end at the elevation of the test table deck. The pitch of the conveyor can be adjusted to the exact pitch necessary for gentle movement of the meters to their destination.

Meters are moved from the repair section on 12x18-in. plastic trays, each of which holds four single-phase meters. When ready for testing, the meters are rolled slowly down the conveyor and into the test room through a plastic curtain, coming to rest against a heavy rubber band stretched across the end of the conveyor. Upon completion of the test, the meters are placed on another tray on the lower deck of the conveyor and are returned to the shop for sealing and boxing before being sent to the field for installation.

OCB Bushing Repair Cuts Outage Time

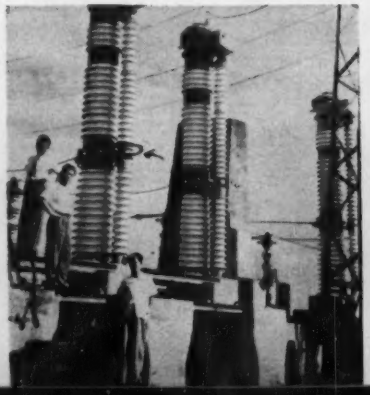
A cracked OCB bushing at Korea Electric Power Co, Ltd, was repaired at a cost of $1.50, to save a $6,000 replacement cost. Furthermore outage time was held to a minimum.

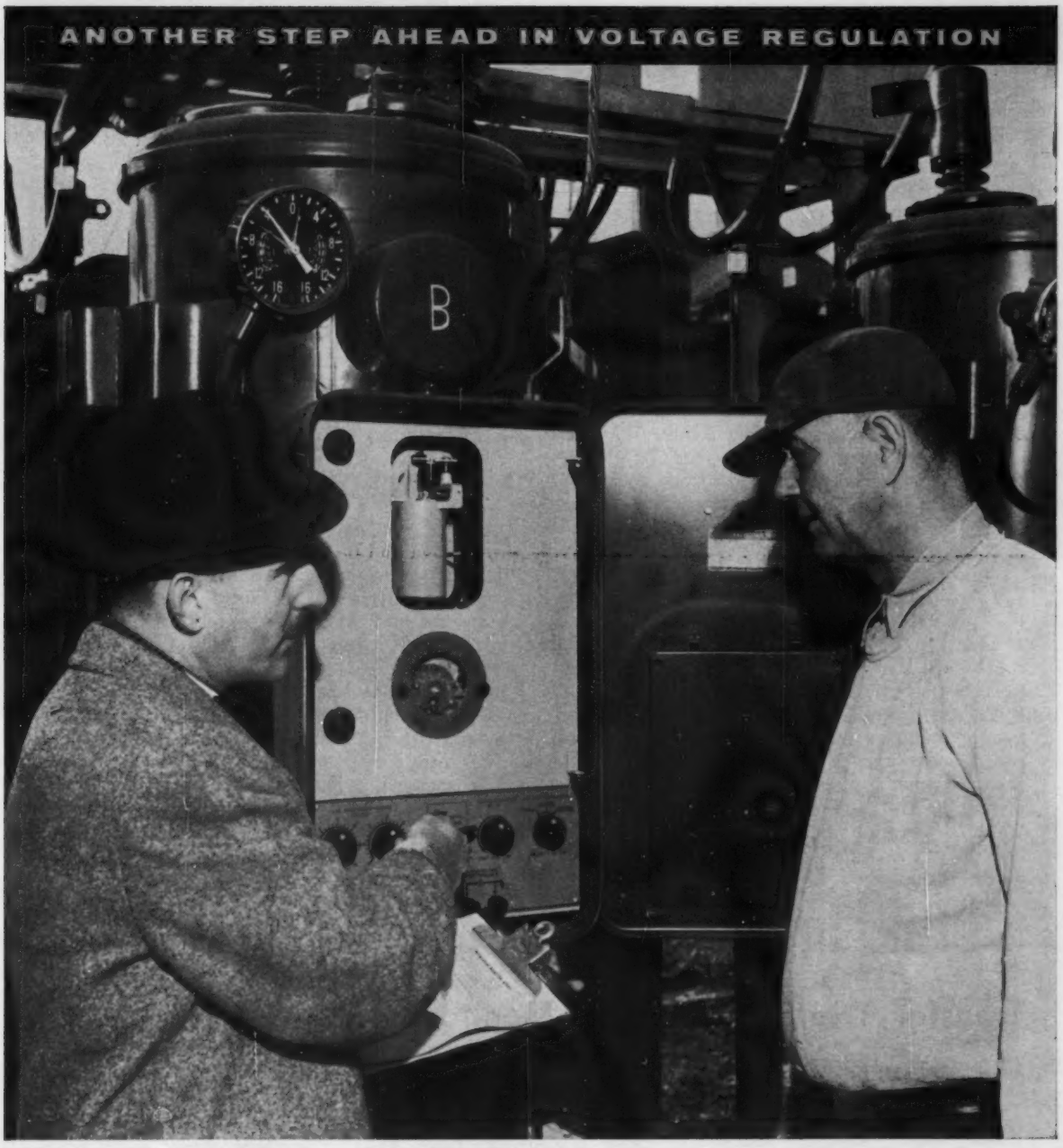
Initially, insulating oil leaking through the crack, located at the bond of the steel band with the insulating porcelain, indicated that a replacement would have to be imported. To minimize outage time, immediate repair of the crack was attempted using a liquid form of Plastic Steel, Devcon A.

The Plastic Steel manufactured by Devcon Corp, Danvers, Mass., is composed of 80% powered steel and 20% plastic. Mixed with a hardener just before using, about ¾ lb of mix was applied with a putty knife. The patch cured without heat or pressure into a solid leak-proof mass.

The 155,000-kva OCB has been in operation since the crack was repaired Sept. 3, 1959, with no evidence of leak recurrence.

(*More EUM on page* 84)





WITH GENERAL ELECTRIC VOLTAGE REGULATORS:

Installation inspection always free!

From the moment a General Electric voltage regulator is shipped, field service specialists of G.E.'s Installation and Service Engineering Department are available on a no-charge basis to provide a variety of initial installation inspection services. These services—embracing 18 specific areas—include inspection of new regulators, setting up productive maintenance programs, and training of customer personnel in the operation and maintenance of regulators.

Available through your nearest G-E sales office, these specialists work effectively with General Electric product design engineers on the one hand, and application engineers on the other to provide *the most extensive regulator field service in the industry.*

When you buy General Electric voltage regulators, you are making a TOTAL VALUE investment—of which installation inspection is just one of the dividends. *Voltage Regulator Products Section, Pittsfield, Mass.* 456-07

Progress Is Our Most Important Product

GENERAL ELECTRIC

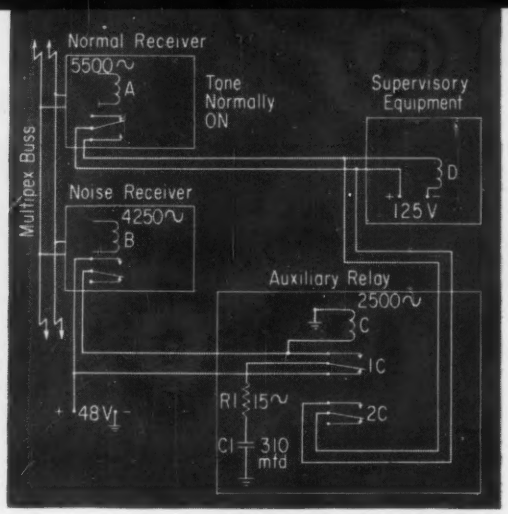
ELECTRIC UTILITY METHODS

E u m

OPERATIONS

Tone Receiver Combats Noise Disturbances

EDGAR A. CLAPP, Communication Supervisor, Arizona Public Service Co, Phoenix, Ariz.



Installation of a tone receiver combats false operation of breakers due to noise caused by disturbances on the microwave path from Phoenix to Arizona Public Service Co's Buckeye APA substation. This simple and inexpensive protection unit disables the supervisory control equipment whenever the microwave is not behaving properly.

The normal tone receiver relay **A** is pulsed by the interruption of the 5,500-cycle tone transmitter at Phoenix. The operation of relay **A** pulses the supervisory control equipment relay **D** which controls the supervisory control system. Tone receiver **B** was added at 4,250 cycles, at a location on a portion of multiplex bus spectrum not in use. Also added were the 2,500-ohm relay, a 310-mfd capacitor and a 15-ohm resistor. When noise is present on the multiplex bus relay, **A** will pulse "false." Relay **B** will also operate on noise anytime relay **A** operates—due to the absence of a tone on the multiplex bus at its frequency.

Operation of relay **B** will pulse relay **C.** The contacts, 2 C, will pick up the supervisory control relay **D.** The contacts, 1 C, transfer the charged capacitor C 1 and resistor R 1 which will hold relay **C** energized for about 3 sec. This is sufficient time to reset and disable the supervisory.

When it is extremely noisy and relay **A** and **B** are pulsing, relay **C** will not release, which thereby makes pulses on normal tone receiver **A** ineffective.

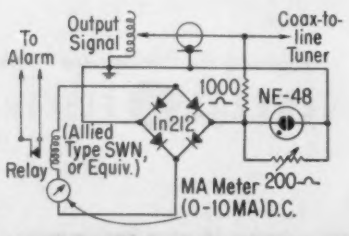
The operating speed of relay **A** and **B** are equal. The same is true of relays **C** and **D.** Therefore, only one false pulse will be received by the supervisory control equipment—a total of 7 pulses is required for operation of a breaker. The equipment is ready for use 3 sec after the trouble is cleared and capacitor C 1 is charged, ready for the next operation. No trip to the substation is necessary.

The protection unit has been in service three years with no false operation of supervisory control equipment due to microwave equipment troubles.

Transfer-Trip Set Efficiently Monitored

***A. N. ROBERTSON,** Electronics & Communication Section, American Electric Power Service Corp, New York*

Transistorized transfer-trip carrier sets are now efficiently monitored by metering a low-current radio frequency circuit to insure proper operation of both the transmitter and the receiver. Furthermore, the same radio frequency circuit can be used to set off an alarm system to indicate whether a fault is in the transmitter or receiver.



The low-current radio frequency circuit referred to above was devised by the Electronics and Communication Section of the AEP Service Corp, N. Y., for metering the transmitter output and for sounding an alarm in case of its failure. This circuit samples the radio frequency output current, rectifies it, and passes the resultant dc through a milliammeter and a sensitive relay, both of which can be located at the switchboard. Gradual deterioration of components can then be observed by noting the meter reading. If the output-current level begins to fall, it is a visual indication that problems are developing.

In case of a low signal, or its complete loss, the relay will drop out, giving an audible alarm to signal the attendant at the transmitting station. In the case of an unattended station, the relay can be connected to operate auxiliary alarm equipment. The cause of this loss of transfer-trip signal can then be traced immediately to the specific defective unit—either transmitter or receiver. Maintenance personnel can be dispatched to the proper location without delay.

Whether used for standby or on-site portable power, electric plant breakdowns can be critical. That's why Onan is beefed up with bigger bearings, shorter-stronger connecting rods and crankshafts, and Stellite valves. *Only* Onan is Performance Certified to deliver every watt of power promised by the nameplate rating.

Only Onan is certified to give you all the power promised by its nameplate

It's a fact that many electric plants on the market today do not deliver the output promised by their nameplate rating.

Every Onan plant is given a rugged workout *under full load* before it is shipped—*your assurance* that the Onan you buy is ready for hard work the day you get it.

But this isn't enough. Independent laboratory inspectors pull surprise inspections to double-check our tests and testing methods. They pull a plant off the line, run it, stop it, load it, overload it, check and recheck. Their torture test gives positive proof of Onan's quality. End result: *Onan's exclusive Performance Certification* . . . your assurance of getting every watt of power you pay for.

So when you're tempted by an electric plant "bargain," make sure its nameplate rating is not "inflated." Be sure you're getting full measure for your money. Remember, *the electric plant that short-changes you in power output is no bargain at any price!* Only Onan is Performance Certified to deliver everything the nameplate promises.

See Onan electric plants soon. Compare before you buy. You'll find your Onan distributor listed in the Yellow Pages. Call him or write direct.

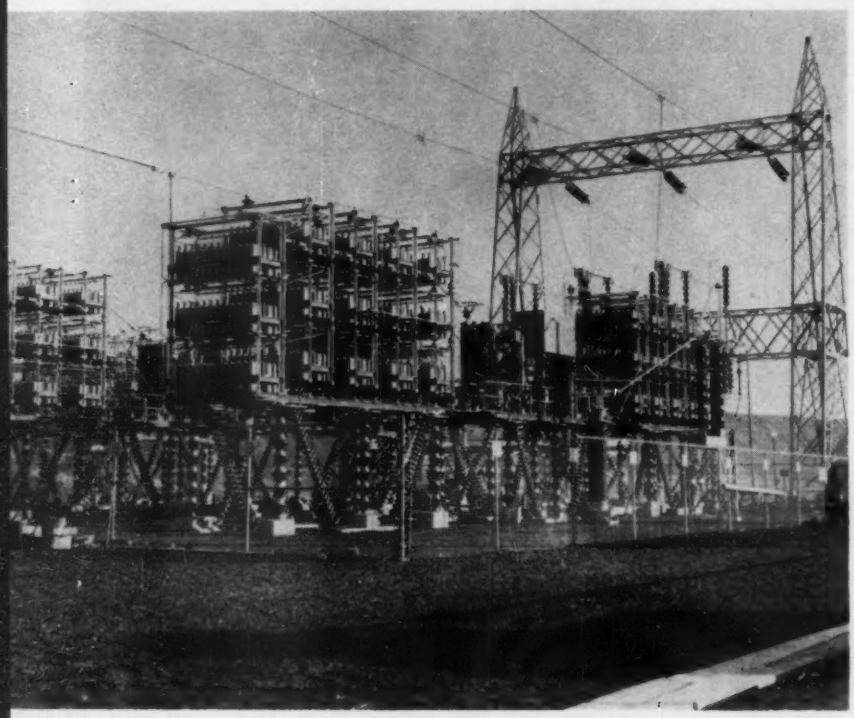
PERFORMANCE CERTIFIED
We certify that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.
Onan
Onan
World's Leading Builder of Electric Power Plants

Onan

ONAN Division, Studebaker-Packard Corporation, 2531 University Ave. S. E., Minneapolis 14, Minn.

Huge Bank of Series Capacitors Used by BPA

This Bonneville Power Administration capacitor substation (below) on the Columbia River in Washington, built by General Electric Co to balance loads on the utility's 345-kv transmission system, has successfully passed field acceptance tests. It is believed by GE to be the nation's largest EHV series capacitor bank.



Because of the encouraging aspects of this, its most recent capacitor installation, the company says it is now in a position to manufacture even larger banks for EHV transmission, incorporating the series capacitor advantages of load building and increased stability limits.

The capacitor bank is composed of 2,160 50-kvar capacitors, divided into six identical blocks, with two blocks for each phase. (Three of the blocks can be seen in foreground of illustration.) Capacitors are held in new aluminum-stack racks and the entire block is mounted on a special insulated platform. According to GE, installation was facilitated by the ease of handling the aluminum racks and the lightweight capacitor units.

Extensive electrical checks were made for a week on by-pass switching, protective gaps, overload relaying and automatic reinsertion. These tests were conducted by BPA and witnessed by representatives from several major United States and Canadian utilities.

The installation was made with provision for the capacitors to be able to withstand earthquake shocks and strong winds.

Automatic Control System Ordered for 500-Mw Unit

A Rockwell-Republic solid-state electronic combustion control system will be used for the steam generator of a new 500-Mw generating unit for Tennessee Valley Authority's Colbert Steam Plant Unit No. 5 at Tuscumbia, Ala. Prime contract for the automatic combustion control and digital data system was awarded to Republic Flow Meters Co, subsidiary of Rockwell Manufacturing Co.

TRW Computers Co, a division of Thompson-Ramo-Wooldridge, Inc, will provide the digital data system with a RW-300 computer as part of the Republic contract for instrumentation and control of the generating station.

Transistorized, miniaturized Republic equipment will control coal pulverizers, fans, and feedwater for the steam generator, which has a capacity of 3,900,000 lb per hr and operates at 2,450 psi and 1,053F. The TRW computer will scan 600 operating variables, signal off-normal operations, and print out data as required by operating personnel.

Early in 1960, Republic and TRW Computers agreed to cooperate in the design, manufacture, and installation of integrated control systems for the electric power industry. The TVA installation will be the first system completed under this agreement.

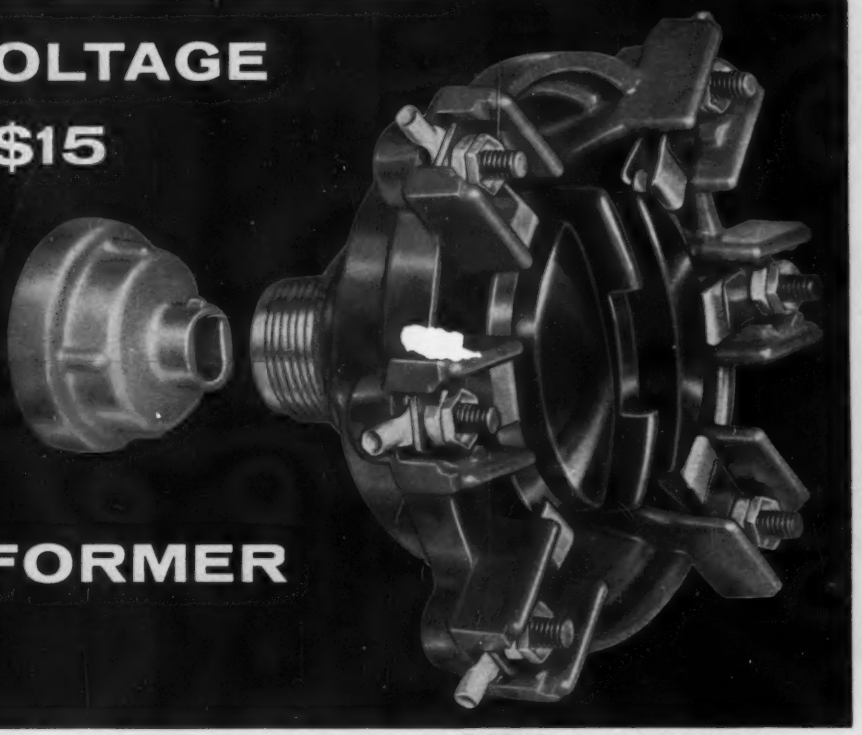
Six RW 300 computers previously purchased from TRW Computers were purchased by Electricité de France for plants at Saint Quen and Chinon.

Use of Crane Permits Cost Cuts in Plant Design

Milwaukee Crane Div of Novo Industrial Corp is supplying what it believes to be the world's largest gantry crane for hoisting, transporting and placing the huge components at the Robert Moses Niagara Power Plant. Total of 6,225 engineering

CONCENTRATION

DUAL VOLTAGE SAVES $15 OR MORE ON EVERY TRANSFORMER



Concentration on one idea has resulted in the new RT&E thoroughly tested and reliable Extern-O-Switch. This redesigned dual voltage switch makes **dependable** cut-over of entire areas to higher voltage at savings of $15 or more per transformer.

Extern-O-Switch body is made of an entirely new compound — a specialized glass-reinforced Polyester thermoset material. It is highly shock resistant and actually extinguishes arcs passed over its surface. Impossible to track, its characteristics are not affected by transformer oil or heat. Electrical insulation levels are increased by 50% with this exceptional material.

The unique externally operated handle reduces changeover to a simple twist of the wrist. Key-type handle cannot be removed unless the switch is correctly positioned. Inside, high pressure contact is assured. New leaf springs behind each contact prevent metal fatigue and provide lasting, positive contact pressure.

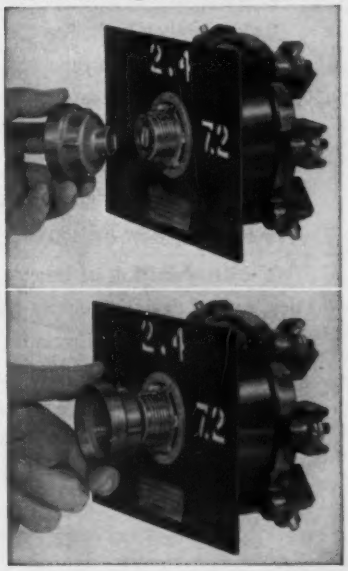
RT&E's concentrated research program developed these improvements to reduce man hours and save money. Protect your investment, look to RT&E — originator of the dual voltage transformer and externally operated switch.

Engineering Talent Concentrated On One Idea — **A BETTER TRANSFORMER**

RT&E CORPORATION

WAUKESHA, WISCONSIN • PORTLAND, OREGON • ARLINGTON, TEXAS

SAFE! Unique keying action between handle and slotted ring around shaft assures positive positioning before handle can be removed.



TT

Can you see any difference?

O-B puts lightning immunity into small pintype insulators--a big added value at no extra price.

Is this just like any other pintype insulator you buy? Does it look the same? Chances are it does.

Take another look. See the scars on the porcelain? These are from repeated electrical discharges many times as severe and destructive as natural lightning. O-B has one of the very few laboratories in the world that can *produce* such a discharge - - and, to our knowledge, the only low voltage pintype that can *take it*.

The combination of unexcelled technical facilities, and a desire to apply these to the development of a low-cost insulator, are unique in the electrical field. The difference isn't in shape, or size, or even price - - the difference is in performance, and in saving the high expense of detection and replacement of lightning-damaged insulators.

Because they seldom have shielding, distribution lines have high exposure to lightning attack. This can't be cured by an insulator, but it can be combated. This is the big extra you get when your lines are insulated with O-B. They don't puncture. They truly do save you money because of this - - a lot of it!

O-B pintypes are as handy to you as your telephone. Graybar can deliver them to your door today if you need them that quickly.

OHIO BRASS COMPANY, MANSFIELD, OHIO

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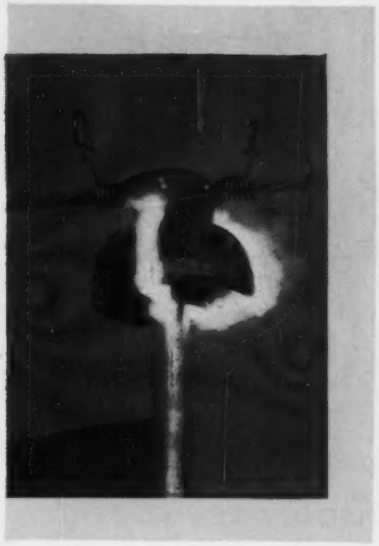
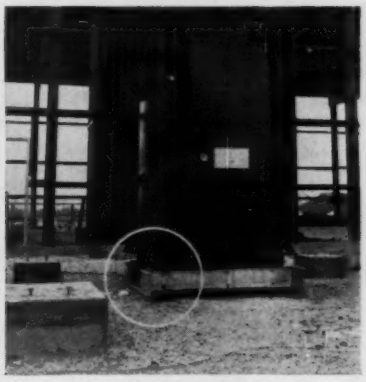


Far more wicked than natural lightning - - this O-B distribution pintype is withstanding an impulse discharge having the phenomenal wave front of 8,000,000 volts per microsecond. Destructiveness of this discharge is many times what can be encountered in service. It will shatter the average insulator but in the case of O-B, it can be applied repeatedly without harm. The insulator on the opposite page shows the result of this extremely severe test. The glaze has been burned by the great heat in the flash, even though its duration was only in the order of 8/100 of one millionth of a second. Otherwise the insulator is perfectly sound. Its full useful life has not been impaired.

When you buy distribution insulators remember what you have just seen. You are also buying the ability of the manufacturer to reproduce the basic design faithfully in large quantities over long periods of time. And you pay nothing extra for this protection to your service.

manhours were spent wrestling with unique design problems posed by the application. This was followed by 56 weeks devoted to manufacture and on-the-site erection of the crane, which is 70 ft high and weighs more than 900 tons.

Open-deck construction used at the plant, instead of the usual above-ground powerhouse, necessitated the crane's outsized proportions. However, it is estimated that the savings in time and construction expense far outweighs the additional cost incurred for the large crane. Technique permitted elimination of the powerhouse, assembly of the power-making components above ground. Then the crane placed components in 13 subsurface pits.



New Use of Anchor-Supported Base

This 29,900-lb, 3-phase transformer (above, rt) has been mounted on a base supported by eight steel screw anchors in lieu of the heavy reinforced concrete base normally constructed for such installations. The 25,000-kva, 34.5-kv to 2.4-kv transformer was installed next to a short-circuit laboratory which is part of A. B. Chance Co's engineering research center now under construction in Centralia, Mo. The center will be ready for operation early in 1961.

Anchors previously were used to support surface-type distribution transformers, but this is the first actual installation for a transformer of this size, says Chance. Eight anchors with 15-in.-dia helixes were installed with a power digging unit to a depth of 7 ft. The anchor shafts were 2-in. extra strong galvanized pipe.

The company pointed out that the installation not only offered appreciable savings in material and labor over a conventional transformer base, but it also cut installation time because no curing period was required—as would be the case with a concrete pad. Similar installations are planned by several electric utilities in the near future, says Chance.

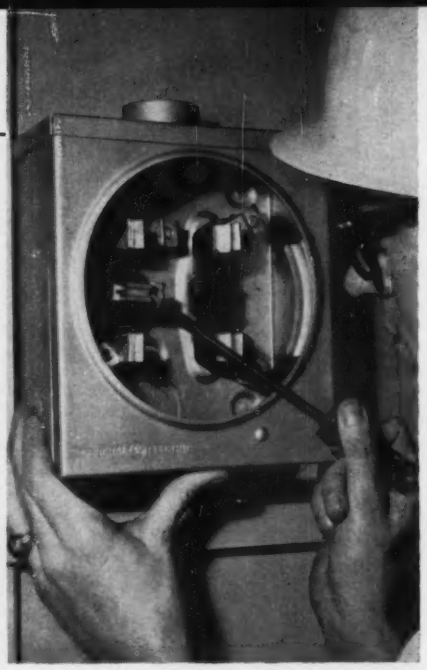
MANUFACTURERS BRIEFS

• **Square D Co** has purchased from Gorham Manufacturing Co a 98,000-sq-ft plant located on 35 acres, near the outskirts of Asheville, N. C., to serve as headquarters for the commercial control division.

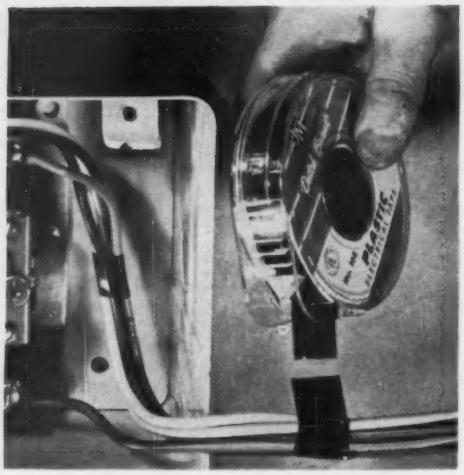
• **Collyer Insulated Wire Co** has begun construction of a 400,000-sq-ft, single-story plant in Lincoln, R.I., to consolidate operations now being carried on at four locations. The single-story design was selected for reduction of materials handling costs in the company's manufacture of electric cables. The company plans to use equipment at the new site which will enable it to make "more complex types of cables designed for specific rather than general use," which it feels are required.

New Equipment

Ringless Meter Socket . . .



. . . provides design flexibility to achieve low cost socket installation and maintenance. Designated SI-60, the new series of sockets are available in three sizes for the 100-amp rating (8 in. wide with lengths of 8.8, 10, and 12 in.) and two sizes for 200-amp demands (8 in. wide with lengths of 10 and 12 in.) Six knockouts are provided in the case. The socket's cover fits snugly over the meter and is held firmly in place at the top by a lip from the case, and at the bottom by a one-piece latch. The latch is inside the case expect for the handle and for the projection needed for sealing. Exclusive with the SI-60 line of sockets are the terminal block assemblies with the one piece combination jaw and connector strap to minimize heat rise.
General Electric Co, Schenectady 5, N. Y.



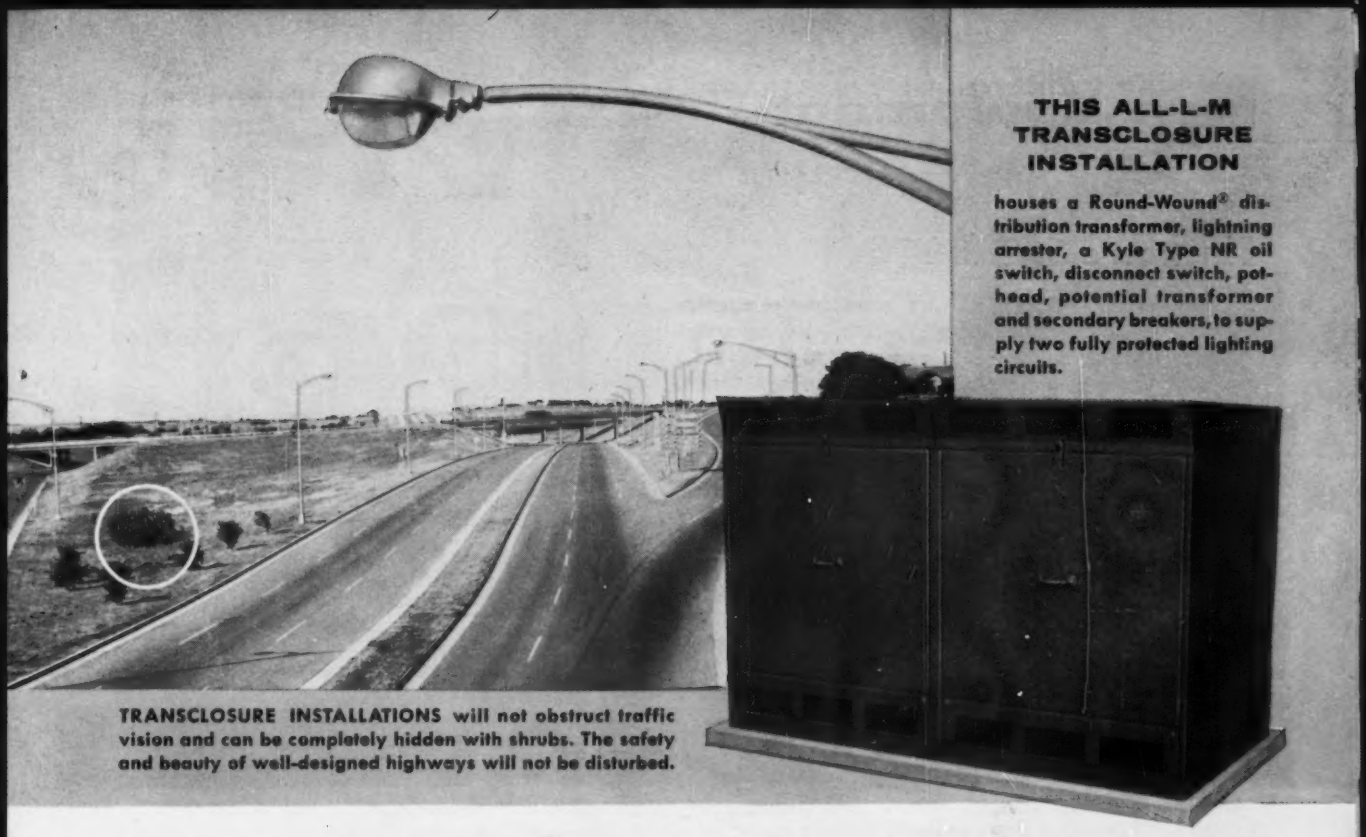
Tape Dispenser . . .

. . . requires only one hand to work, thereby permitting neater and tighter splices in awkward locations, or with complex assemblies in which one hand is needed to hold components in place. The new dispenser cuts the plastic tape with clean straight ends by a novel "puncture and slice" method. In addition, the tape is not stretched during cutting, thus eliminating loss of dielectric strength and adhesion, often caused by stretch-cutting plastic tape. Each new dispenser, No. 165, contains 66 ft of ¾-in.-wide, 7-mil-thick, Dutch Brand Plastic Electrical Tape.
Johns-Manville Corp, Dutch Brand Div, 22 E 40th St, New York 16, N. Y.

Power Capacitor . . .

. . . achieves space saving advantages plus unusually cool operation. Rated 2,400 v through 7,960 v, 60 cycle, single phase with single or double bushings, the new 50-kvar and 100-kvar Cornell-Dubilier power capacitors are for use in substation stack racks and pole-mounted racks on utility transmission and distribution systems. The 50-kvar unit weighs 92 lb, and has dimensions of 15½x4½x22½ in. With the same width and depth as the 50-kvar unit, the 100-kvar "Slim Jim" capacitor—with the addition of 19 in. in height—provides twice the kvar per sq ft as a rack with 50-kvar units. Similar space savings are also possible in pole-mounting this equipment. The "Slim Jim" has about the same heat dissipating surface area as two 50-kvar units. The new capacitors retain all the electrical features of previous Cornell-Dubilier capacitors.
Federal Pacific Electric Co, 333 Hamilton Blvd, South Plainfield, N. J.

(*More New Equipment on page* 92)



THIS ALL-L-M TRANSCLOSURE INSTALLATION

houses a Round-Wound® distribution transformer, lightning arrester, a Kyle Type NR oil switch, disconnect switch, pothead, potential transformer and secondary breakers, to supply two fully protected lighting circuits.

TRANSCLOSURE INSTALLATIONS will not obstruct traffic vision and can be completely hidden with shrubs. The safety and beauty of well-designed highways will not be disturbed.

New L-M Transclosures Save $1,750 On Each Highway Lighting Transformer Installation

New enclosure with modular construction offers savings in cost, erection time and space; permits transformer installations at the load center.

by C. W. PETERSEN, Product Manager
Line Construction Materials
Line Material Industries

Costs of expressway and highway lighting can be greatly reduced by use of the new L-M Transclosure(TM) for all transformer installations. The Transclosure will house a standard oil-filled transformer, lightning arrester, oil switch, disconnect switch, pothead, secondary breakers and potential transformer. Using the Transclosure instead of the conventional concrete block or brick housing offers an estimated saving of $1,750 per transformer installation. On a projected 60 miles of highway, where 100 to 125 installations are expected, a total saving of from $175,000 to $218,000 is anticipated.

Basically the Transclosure is a weatherproof enclosure, fabricated of heavy-gauge steel, to be mounted on a concrete pad. It houses the transformer and associated equipment. It provides ample ventilation for the transformer by means of vents at top and bottom, with baffles to prohibit entrance of all foreign objects, including wildlife. Removable primary and secondary doors can be padlocked to prevent unauthorized personnel from entering, yet they provide complete and easy access to the equipment.

Interlocking design assures a weatherproof housing; the sloped roof sheds rain. Modular construction permits ganging the units to provide whatever space is required. Units may also be expanded vertically by installation of larger side panels and bottom vents. Transclosures are available in three sizes, to accommodate transformers up to 100 kva. Small in size and light in weight, they are designed to be assembled at the job site. A complete installation, including transformer and associated equipment, has been installed with less than two man-days of labor.

The clean, low lines produce a silhouette that does not detract from highway beauty or obstruct traffic vision. Low shrubs will hide the entire installation completely. Transclosures may be installed precisely at the lighting load center, eliminating all overhead construction and producing the shortest and most economical secondary runs.

Get Complete Information

These are just a few of the reasons why many engineers are specifying this new approach to inexpensive highway lighting. For complete details, contact your L-M Field Engineer or Lighting Engineer or write me direct at Line Material Industries, Milwaukee 1, Wisconsin. 407

LINE MATERIAL® Industries Transclosures

McGRAW-EDISON COMPANY

DISTRIBUTION TRANSFORMERS • KYLE RECLOSERS AND OIL SWITCHES • FUSE CUTOUTS AND FUSE LINKS • LIGHTNING ARRESTERS.
POWER SWITCHING EQUIPMENT • PACKAGED SUBSTATIONS • CAPACITORS • REGULATORS • OUTDOOR LIGHTING
LINE CONSTRUCTION MATERIALS • PORCELAIN INSULATORS • FIBRE PIPE AND CONDUIT

McGRAW-EDISON

New Equipment

(*Continued from page* 90)

Electronic SRT . . .

. . . was developed for 20/34.5-kv grounded-wye circuits. Constructed to meet requirements of high-voltage distribution systems, the new SRT's have a 150-kv BIL, are available in single phase ratings of 10 through 167 kva, with a secondary rating of 120/240 v. Solid-state electronic components, completely encapsulated and weatherproofed, sense voltage at the utilization level and control a shaded pole motor-driven tap changer. Secondary voltage is maintained within a 3½-v bandwidth about a regulated output. An adjustable range of regulation makes the SRT's applicable to any part of the distribution system —near a substation, at a midpoint of a feeder, or at the end of a feeder. Regulation in four 2½% steps can be set for 92½ to 102½, 97½ to 107½, or 102½ to 112½% of the rated primary voltage.

Line Material Industries, McGraw-Edison Co, Milwaukee 1, Wis.

Aluminum-Cap Insulator . . .

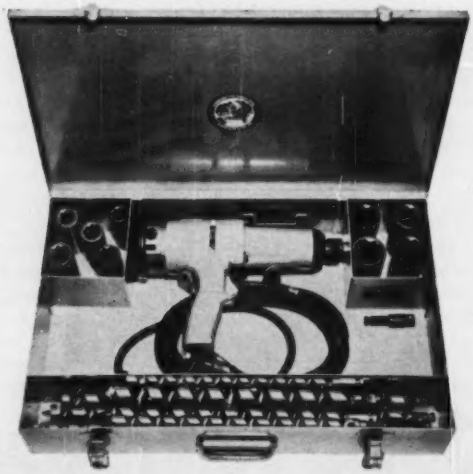
. . . offers high corrosion resistance in industrial and marine atmospheres. Use of aluminum caps and studs in the 10-in. extra-high-voltage suspension insulators not only provides longer service life free from corrosion problems, but cuts 2 lb from the weight of the ordinary suspension of this size—64 lb fewer on a 230-kv, 16 double-string deadend. Reduced weight simplifies handling, transporting and changing a string of insulators.

A. B. Chance Co, Centralia, Mo.

Impact Wrench . . .

. . . bores holes, runs and tightens nuts to save lineman's time when installing pole crossarms. The new All-Purpose Kit No. 336C is comprised of a steel tool case, nine bits (½x10 in. to $1\frac{1}{16}$x18 in.), and nine double square, extra long sockets ($\frac{9}{16}$ in. to $1\frac{1}{16}$ in.) for use with the SIOUX No. 336 Electric Impact Wrench, as equipped with a $\frac{7}{16}$-in. quick change chuck. The impact wrench bores rapidly and the quick change chuck allows for a rapid change to the socket tool for nut running and tightening.

Albertson & Co, Sioux City, Iowa.



Industry-proved through a quarter century of service...THERE'S NO DOUBT ABOUT NEOPRENE

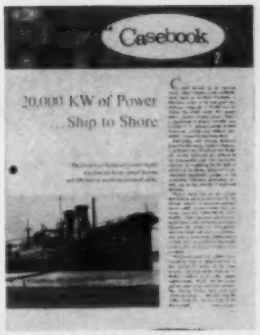
Now you can zip through Baltimore at 45-60 mph — even at night. A total of 826 powerful fluorescent lights brighten the roadway, make high-speed driving safer. Neoprene jacketing was specified for over a million feet of illuminating cable used in this installation.

OVER A MILLION FEET OF NEOPRENE-JACKETED CABLE ILLUMINATES BALTIMORE EXPRESSWAY

Tough, pliant, abrasion-resistant neoprene meets Maryland Roads Commission specifications

The Baltimore Harbor Tunnel Expressway—16 miles of limited access dual lane highway—uses over a million feet of illuminating cable . . . and every foot of that cable is jacketed with durable neoprene synthetic rubber. Neoprene-jacketed cable, supplied by Walker Brothers, met specifications established by the Maryland Roads Commission for illuminating cable with a "tough, pliant and abrasive-resisting sheath."

Neoprene jacketing combines toughness and abrasion resistance with many other desirable qualities. It resists weathering, chemicals, temperature extremes and deformation from cable clamps. It has proved—in actual service—that "neoprene jacketing" means long, economical protection for electrical cable. E. I. du Pont de Nemours & Company (Inc.), Elastomer Chemicals Department EW-1, Wilmington 98, Delaware.



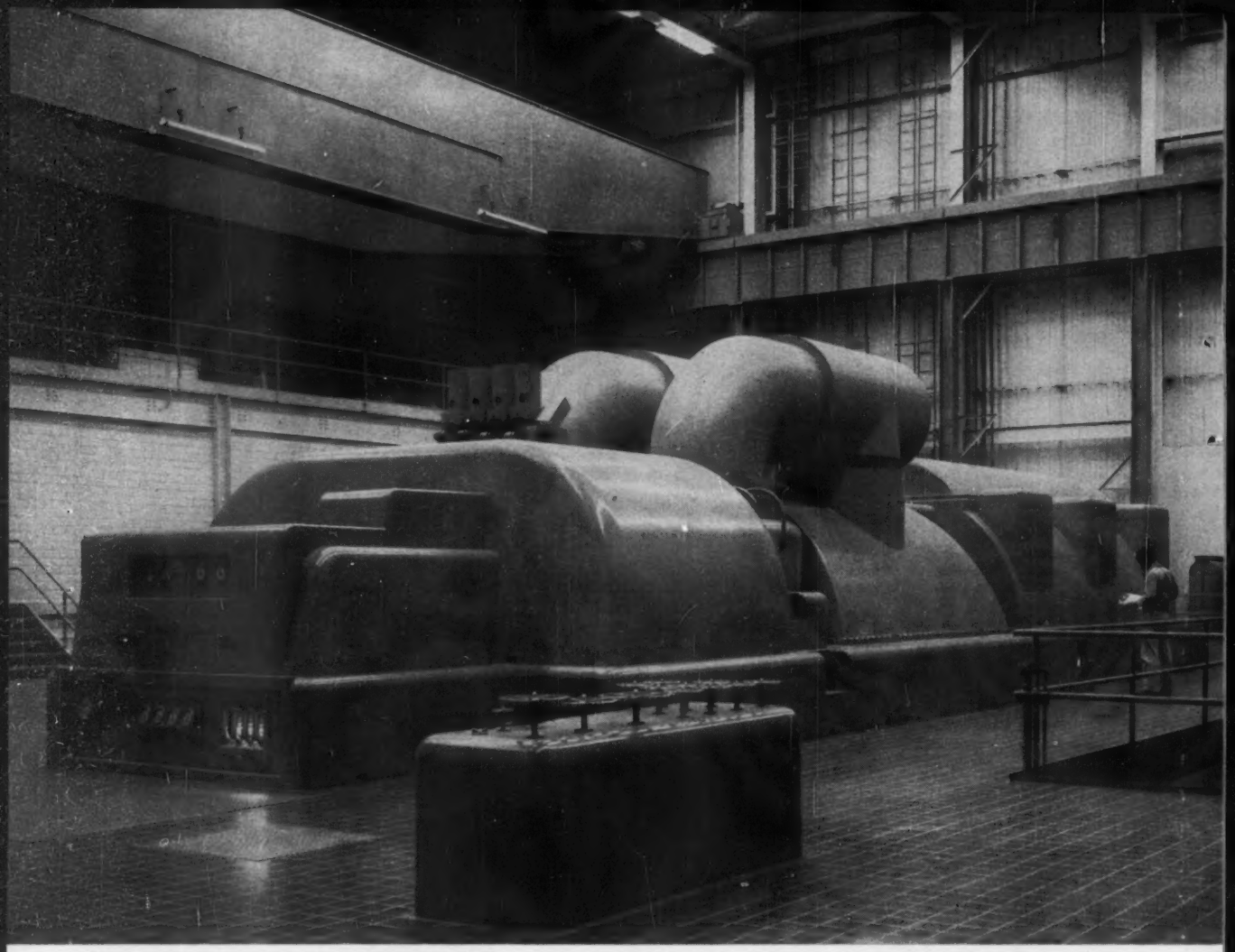
Free—Du Pont's new WIRE AND CABLE CASEBOOK

Each issue contains case histories from the electrical industry on the use of neoprene jacketed cables. Subscriptions free on request.

DU PONT REG. U. S. PAT. OFF.

NEOPRENE
SYNTHETIC RUBBER

Better Things for Better Living . . . *through Chemistry*



Complete service complements product reliability when you install a General Electric steam turbine-generator such as this 125,000-kw, tandem-compound, double-flow, reheat unit in the E. D. Edwards Station of Central Illinois Light Company

Always an evaluation factor— General Electric's personalized turbine-generator service

General Electric's complete service program for steam turbine-generators is personalized to your specific system requirements—to help you in your continuing efforts to produce reliable, low-cost electric power. This nation-wide service is readily available, to give you:

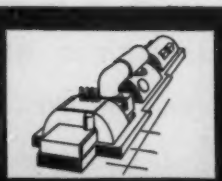
- turbine and generator engineering consultation
- installation planning and direction
- accelerated, on-time start-ups
- training of your personnel
- periodic service calls and consultation
- maintenance inspection and planning
- renewal parts scheduling
- priority repair service

At General Electric, service is always part of the total value you receive . . . it is not curtailed when prices are soft, when orders are slow, when profits are down . . . it is *always* part of your steam turbine-generator. 244-02

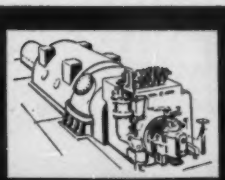
Progress Is Our Most Important Product

GENERAL ELECTRIC

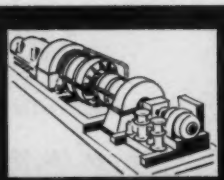
General Electric Turbine-Generators Help Keep Power Costs Low



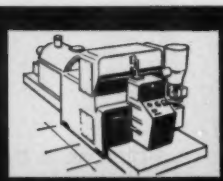
Steam turbine-generators for large blocks of power



Steam turbine-generators 100,000 kw and lower



Gas turbines for peaking, base load, combined cycles



Mechanical drive steam turbines for auxiliaries

Electrical World

JANUARY 16,1961

Management Newsletter

Two Halves Are More Than a Whole

"Nonsense" cries the scientific-minded citizen without even consulting his slide rule. "You can't make something bigger by cutting it in half." But a host of American corporations, including many electric utilities, would have to disagree. These are the companies that have put the scissors to their stock, and found that the two halves have more value in the market than the single share.

A just-completed survey of a number of electric utilities that have recently split their stock seems to indicate that the two-for-one and three-for-one formulas increase the market price of a company's outstanding stock. This survey looked at stock splits occurring between January, 1954, and December, 1958. During this period, market averages rose and fell, testing the effect of the splits under both bull and bear conditions. To measure the change in the market price of each stock, the research team used a two-year period, taking the price of the share at the beginning of the calendar year before the split, and at the end of the following year. They did this to eliminate the speculation effects which are of short term significance only. These occur when a split is rumored. The price of a share tends to rise abruptly, only to settle back to its normal level shortly after the split takes place. By using the two-year period, the error that this temporary rise and fall in price might cause in estimating the change in stock market value is minimized.

Fourteen utility stocks which split between January, 1954, and December, 1958,

came under survey. Price increases of these shares during the applicable two-year periods were compared against price increases of the Dow Jones Utility average during the same period. Taken together, stocks of the 14 companies showed an increase of 21% when price jumps due to increased dividends were deducted. The increase in the utility average for the same periods was 16%. So, the split stocks did quite a bit better than their un-scissored counterparts.

Of course, during the two-year periods over which price changes were measured, any number of factors could have influenced the price of the split shares. It certainly would not be accurate to say that splitting was the only factor. But the survey went on the basis that whatever factors affected individual shares would also have influenced the utility average. And so, other factors were considered to have canceled each other out.

If the survey's results are accurate, then when it comes to common stock, two halves seem to be more than the whole. But this brings up a perplexing question. Why? Why do buyers place more value on two shares representing a percentage of ownership in a utility than they do on one share representing the same percentage of ownership in the same company?

People Like Round Lots

The most important reason is the desire of many investors to own stocks in 100-share lots (round lots) rather than lots of less than 100 shares (odd lots). People are more willing to buy 100 shares selling at $25 each than 25 shares selling at $100 each, despite the fact that the corporations involved might be equal in earnings, dividends and other values. The "why?" of this situation is lost somewhere in the labyrinth of human nature. People just feel better saying "I have 100 shares of ABC Corp" than "I have 25 shares of XYZ Enterprises."

There is some tangible justification for this human desire to trade in round lots. Shares listed on the New York Stock Exchange carry a charge of 25¢ per share as a penalty to the buyer or seller of an "odd lot." This amounts to 50¢ per share on a round turn.

In the over-the-counter market for unlisted stocks, the penalty for odd lots varies, but it may be much more than that on the Exchange. So, it costs money to deal in odd lots. But most authorities agree that the penalty charges are not great enough to account for the preference for round lots. Human nature takes the blame.

Security salesmen are aware of the appeal of 100 share lots. And like all other salesmen, they like to sell what's easiest. So they normally suggest stocks which the customer can buy in a round lot. This naturally includes more stocks selling at low prices than high since more people have $2,000 to invest than $6,000. And so there is more demand for the less expensive shares. A company which splits its stock two-for-one, bringing the price per share from $60 to $30, increases the demand for its stock. While the vast increase in demand is to a large extent offset by the increase in supply achieved in the split, it is nevertheless sufficient to push the price up a bit, perhaps to $31 or $32 a share. And the higher level of trading in the stock seems to be capable of sustaining it at the higher price.

But why stop now? If the market places more value on the $60 share after it's split two-for-one, why not split it three-for-one? Won't that push its market value even higher? Wouldn't five-for-one be better still? Certainly more people can buy round lots of a $12 stock than of a $30 stock.

Again we look to human nature for the answer. People generally seem to regard

stocks selling at a very low level as speculative stocks. They become suspicious of the quality. And the analysts who advise their investments usually feel the same way. Investors in stocks of electric utilities are customarily looking for maximum security of investment and safety of income, combined with a reasonable chance for market appreciation. Quality is most important to them, and stocks at a very low level somehow manage to give the impression of lack of quality. This means that the demand for a stock, split down to a very low price, diminishes rather than increases.

But where is the dividing line? Where does a stock cease to become a solid investment with maximum market appeal and take on the non-quality aroma which seems offensive to the investor, and deadly to demand? Numerous polls of leading security analysts indicate that the most desirable price at which a utility stock should sell to obtain maximum price consistent with the company's performance, is somewhere in the range of $20 to $25 per share. The upper limit of this range is flexible. Some analysts hold that $20 to $50 is a proper price for a utility stock. But the lower limit seems firm. A utility which splits its stock to a level below $20 is putting its quality image in jeopardy. And as the new price moves to even lower levels, the demand for the stock is dropping.

Management is well aware of the existence of this bottom, and is careful to keep the price of a stock subsequent to a split above the $20 line. As a result, the combined price of the two new shares is generally a bit higher than the price of the one original share.

The advantage of a split to the stockholder is obvious. A man holding 50 utility shares selling at $75 per share on the Exchange owns stock worth $3,750. Then the utility splits three-for-one. The increased demand for the stock raises the price of the new shares from $25 to $26 per share. The stock holder now holds 150 shares at the new price, making the market value of his investment $3,900. His investment has increased in value simply because of the split. There's no other explanation.

Splits Help Management

But this increase in the market price of the shares outstanding isn't worth a penny in the accounts of the utility. So, why should a company split its stock? What difference does it make to the utility whether the stock is favored by heavy demand or not? Unless the company is planning new equity financing, where it would stand to benefit from a higher market evaluation of its shares, why should it go to the trouble of splitting?

Textbooks on the subject answer this question by stating that the corporation may split to widen its base of ownership. But this doesn't really solve the problem. It just re-states it in different words. We could again ask the question, "What are the advantages of the wider base of ownership?"

The advantages vary from company to company. An industry which manufactures basic materials for sale to other industries might not be too concerned about the number of shareholders. Its products are sold to relatively few buyers, and the success of the firm is more dependent on the quality of its product than it is on public opinion.

But a concern which sells its product directly to the consumer would be vitally interested in its base of ownership. That's because the success of its ventures is to some extent dependent on the good will of the people who buy the product. The more stockholders such a company has, the more spokesmen it has for its products in the marketplace.

Electric utilities certainly fall into the second category, and perhaps to a greater extent than manufacturers. For one thing, they are selling their product directly to the consumer. But even more important, they are battling a communication problem. They are trying to convince the public that the shareholder-owned utility really belongs to the people and not to the small group of businessmen that people sometimes think of when they hear the phrase "private power." Utilities are particularly interested in having millions of spokesmen in the marketplace and, equally important, at the polls when power issues are put to a vote. But this isn't the only reason.

Utilities are continuously financing, and some of this financing is done through common stock. With this in mind, it is of great benefit to a utility to keep the market value of its stock at the highest level consistent with earnings, dividends, and prospects. Since a price somewhere between $20 and $30 a share seems to be the area where highest market evaluation is found, this is a beneficial price range for a utility stock. In addition, the broad base of ownership means more potential customers for the new issue.

In selling bonds, a problem which is foreign to no utility, stock splits can, at times, be helpful. This is because of what the split does to the price earnings ratio of the shares. If a company splits two-for-one, then the earnings per share figure is exactly half of what it was before the split. But as we have seen, the price per share is usually a little more than half of the pre-split figure. This means that the price earnings ratio of the stock is higher. Security analysts generally look upon this as a favorable sign indicating that the market is placing added value on the company in view of its future prospects. So, provided the price does not get completely out of line with earnings, a company with a higher price-earnings ratio can usually expect a more favorable reception when it ventures into the money market.

Another reason for the stock split is to keep the size of the earnings per share figure, and the size of the dividend from becoming too large. One American manufacturing company has split its stock several times since 1915. The ratios of the splits have been as high as four-for-one. Today, its earnings per share figure is only slightly higher than the average for its industry. But without these splits, the present earnings per share figure would be close to $700 with the annual dividend running at about $400. The danger of such a figure is that it attracts unwarranted criticism. Some groups would cite such a dividend as an indicator of excess profits. But the same earnings spread over many more shares, and the resulting lower dividend, will go unnoticed.

A final reason why stock splits often make sense is so obvious that it is frequently overlooked. If a split is beneficial to the shareholders, it is beneficial to the company. For the shareholders are the company. They own it just as truly as the proprietor owns the country store.

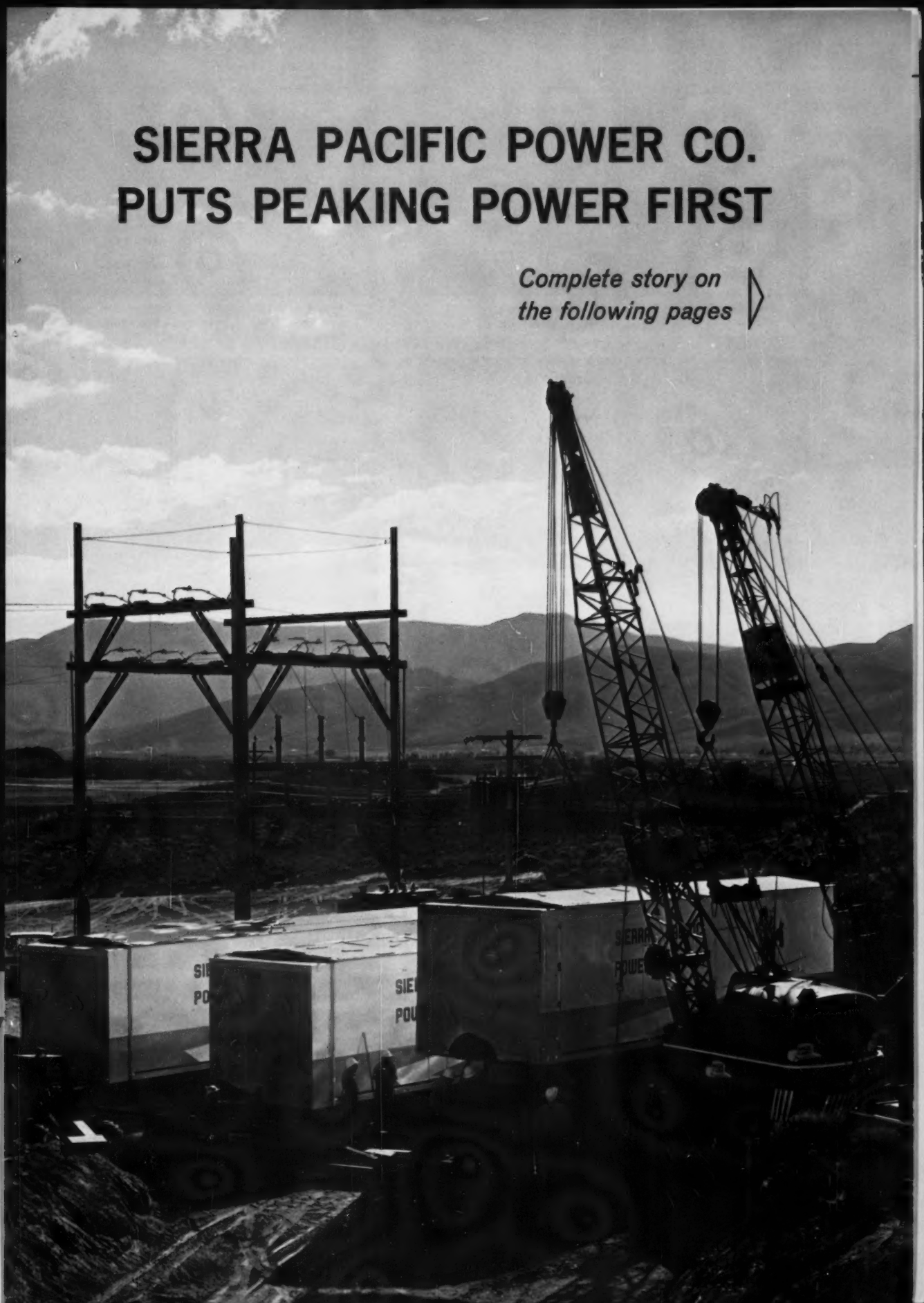
There are many advantages of the stock split both to the shareholders and to the operation of the company. Most of them hinge on the basic advantage of putting the market price of the stock at the optimum level. In a growing economy, and in a growing industry, the market value of a share tends to rise. The stock split is a simple device for keeping a stock from growing too big for its own good.

If the present sideways drift of business in America is checked in 1961, as most commentators seem to think it will be, stock prices will again begin to rise. And more and more companies will find their shares climbing in price until they outgrow the area of heaviest demand.

To correct this situation, many manufacturers and utilities will get out the scissors and begin cutting up the stock. And more often than not, the resulting halves will have more value than the whole.

SIERRA PACIFIC POWER CO. PUTS PEAKING POWER FIRST

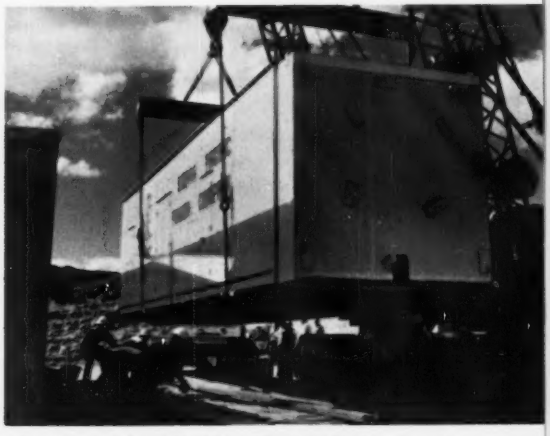
Complete story on the following pages



1. Five low-boy trailers begin 35 mile trip from rail yards at Reno to the Brunswick Substation at Carson City.

2. Electro-Motive units, plus 6000 KVA step-up transformer and fuel tank, begin arriving at site evening of October 3.

3. Crews begin installing transformer, fuel tank and associated equipment, while railroad tie beds are laid for peaking plant.



4. Last of four Peaking Plant units is lowered into place from its trailer by large cranes.

5. The Electro-Motive plant is ready for final electrical connection and piping at the end of second day.

AT CARSON CITY... peaking plant in place in 19½ hours

The third Sierra Pacific Peaking Plant, installed at Carson City, demonstrates the high mobility and flexibility of the Electro-Motive equipment. Starting at 8:00 A.M. on October 3, the Electro-Motive MU-60 scheduled for Carson City was loaded from rail cars onto low-boy trailers for the 35 mile trip to Carson City. Loading was completed at 3:00 P.M. and the caravan arrived at the plant site at 7:30 P.M. Beginning at 8:00 A.M. on October 4, the three 2000 KW generating units, control unit, 6000 KVA transformer and 20,000 gallon fuel tank were unloaded and placed in position by 5:00 P.M. Photos detail moving and installation over 19½ hours.

To meet winter peak demands . . .

SIERRA PACIFIC POWER CO. ADDS THREE 6000 KW PEAKING PLANTS

The Sierra Pacific Power Company is meeting anticipated 1960-61 Winter peak demands with 18,000 KW generated by two new 6,000 KW Electro-Motive Peaking Plants installed at Reno, and a third plant installed near Carson City, Nevada.

PEAKING POWER COMES FIRST

Base load power supply on the Sierra Pacific system is purchased from Pacific Gas and Electric Company and is transmitted across the Sierra-Nevada range from Summit substation 40 miles west of Reno. In addition, Sierra Pacific Power Company supplements this base load with four small hydro plants with about 9,000 KW capacity. With the addition of the three Electro-Motive Peaking Plants, Sierra Pacific is putting peaking power first, in their six year plan of system expansion, to meet load growth and peak demands.

Sierra Pacific expects winter peaks on the system ranging up to 136,000 KW during the months of November through February. Peaks will occur between 5:00 and 7:00 p.m., and will require Peaking Plant operation of one to four and a half hours daily.

REMOTE CONTROL OPERATION

The Electro-Motive Peaking Plants are remotely controlled from the system dispatch center at Reno. The dispatch center is located 35 miles from the Carson City installation and three miles from the Reno Peaking Plants. Remote supervisory control allows the Peaking Plants to start up, synchronize, go on the line and operate unattended. Output of the units is fed directly into a bus through a transformer connected to the system base supply.

ECONOMICAL PEAKING POWER

The total installed cost of the three Sierra Pacific Peaking Plants (including site preparation and all auxiliary equipment) was below estimate, and considerably below the cost of base load generating equipment designed to do the same job. Decentralized Electro-Motive Peaking Plants were the lowest cost solution to Sierra Pacific's immediate problem.

Electro-Motive Peaking Plants themselves, together with control equipment, connecting cables, lube oil and supplies, averaged $88 per KW, delivered at Reno. Locating units at or near load centers provides saving in losses at peak load. Each generator is rated 2000 KW/2500 KVA, .8 power factor. This provides vars for voltage regulation benefits at the time of peak.

For a detailed photo story of the Carson City installation, see the opposite page.

AT RENO . . . two MU-60 peaking plants back-to-back

Two Electro-Motive MU-60, 6000 KW, Peaking Plants are installed back-to-back at Reno—first such installation in the country. This installation illustrates the building-block capabilities of the basic Electro-Motive Plant design.

Such Peaking Plants can be installed with any KW capacity from 2000 KW up, in increments of 2000 KW. Provision for expansion is built in, too, making it possible to increase any given capacity from 2,000 KW to 10,000 KW utilizing same control units.

ELECTRO-MOTIVE DIVISION · GENERAL MOTORS

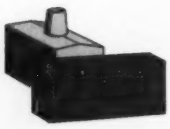
LA GRANGE, ILLINOIS • **Offices:** Chicago, New York, St. Louis, San Francisco

In Canada: General Motors Diesel Limited, London, Ontario

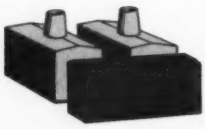
Electro-Motive peaking plants now available in capacities up to 10,000 KW

The Electro-Motive peaking equipment line contains both Diesel and dual-fuel plants in a range of sizes, which permit matching the plant to exact requirements for the most economical and efficient operation at the lowest investment. When load growth occurs, additional generating units may be added at low incremental cost to bring the plant up to desired size.

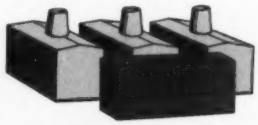
The reliability of Electro-Motive peaking units results from many years of operating experience with the 25,000 GM-567 Diesel engines now in service. This engine is the heart of the peaking plant. Control equipment for the peaking unit has evolved over a period of six years through more than 100 prototype plants. And behind this proven, reliable plant, Electro-Motive stands as a single-source manufacturer with single-source responsibility for your peaking power requirements. Ask your Electro-Motive representative for complete details. With prompt action, Electro-Motive Plants can be handling your next peak load.



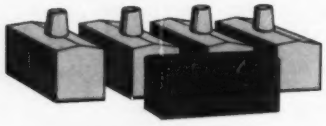
MU-20 2000 KW Diesel
MU-14DF 1000 KW Dual-fuel



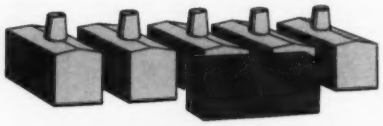
MU-40 4000 KW Diesel
MU-28DF 2000 KW Dual-fuel



MU-60 6000 KW Diesel
MU-42DF 3000 KW Dual-fuel



MU-80 8000 KW Diesel
MU-56DF 4000 KW Dual-fuel



MU-100 10,000 KW Diesel
MU-70DF 5000 KW Dual-fuel

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS La Grange, Illinois
Offices: Chicago, New York, St. Louis, San Francisco
In Canada: General Motors Diesel Limited, London, Ontario

Survey Shows: Utilities, Builders Like MH

The Medallion Home program is four years old. But what kind of acceptance has it attained? Is it doing the job it set out to do? Are utilities going to support it in the future as they have in the past, or has the point of promotional saturation been reached and is apathy now going to set in?

Some answers to these questions were found in a recent survey of local Medallion Home activities by Ebasco Services Inc.

Object of the survey was to provide utility sales executives with a better basis for evaluating their own Medallion Home programs, and to give them some yardsticks for measuring their own efforts and results.

Utilities like the fact that the Medallion Home concept marks a new era in utility residential marketing, they like the national advertising support being given the program, and they are in favor of the fact that it is a "package" they can promote with the builder to the customer, Ebasco said.

There are shortcomings, to be sure, but those companies queried believe that these shortcomings will be overcome as more experience is gained.

Of 143 companies questioned, 93 answered the survey, of which 57 are straight electric and 36 combination. The companies served 29,375,000 residential and rural customers in 1959 (58% of the total United States).

Most of the utilities started promoting Medallion Homes in 1958. More companies promote the Bronze Medallion than the Gold, but the trend is changing. The future will see a greater accent on the Total Electric or Gold Medallion Home.

For many companies 1958 and 1959 were the years they swung to electric heat promotion. But few companies ascribe their decision to promote electric heat to their adoption of the Medallion Home Program. Only 17 companies said it had any effect.

Standards for the Gold Medallion have been established by over 90% of the utilities. More than 80% have Bronze standards. Thirteen companies have no provision for the Bronze, and six have none for Gold.

Only six companies have standards for mobile homes, but 43 have standards for apartments.

One of the jobs of the utilities participating in the program is to police the Medallion standards in their area. Various methods are used, but some of the most common are:

- Inspection by general office personnel, sales representatives or district manager;
- Inspection by builder representatives, home economists or heating specialists;
- Periodic checks during construction and regular contacts with new owners during first and second year of occupancy.

(*Continued on page* 108)

Results of Program (13 companies)

	1958	1959	Budgeted 1960
No. of housing starts in service area	148,435	167,978	160,500
No. of Bronze Medallion Homes built	9,802	18,812	23,749
Bronze Medallion Homes as % of housing starts	6.6%	11.2%	14.8%
No. of Gold Medallion Homes built	937	3,967	7,725
Gold Medallion Homes as % of housing starts	.6%	2.4%	4.8%
No. of completely electrically heated homes built	6,160	9,304	15,045
Completely electrically heated homes as % of housing starts	4.1%	5.5%	9.4%
No. of electric ranges sold in area	127,523	130,815	160,700
% increase	n.a	2.6%	22.8%
No. of electric water heaters sold in area	66,345	82,682	78,130
% increase	n.a	24.6%	5.5%
Residential kwhr sales	14.97 billion	16.2 billion	17.8 billion
% increase	n.a	8.5%	9.9%
Residential kwhr sales per customer	n.a	3,156	n.a
Residential revenues	$399.8 million	$428.8 million	$467.7 million
% increase	n.a	7.3%	9.1%
Residential revenue per customer	n.a	$83.36	n.a
EAR attributable to Gold MH promotion	$221,029	$860,547	$1,888,849
EAR attributable to Bronze MH promotion	$635,754	$1,214,656	$1,647,007

Allowances to Builders

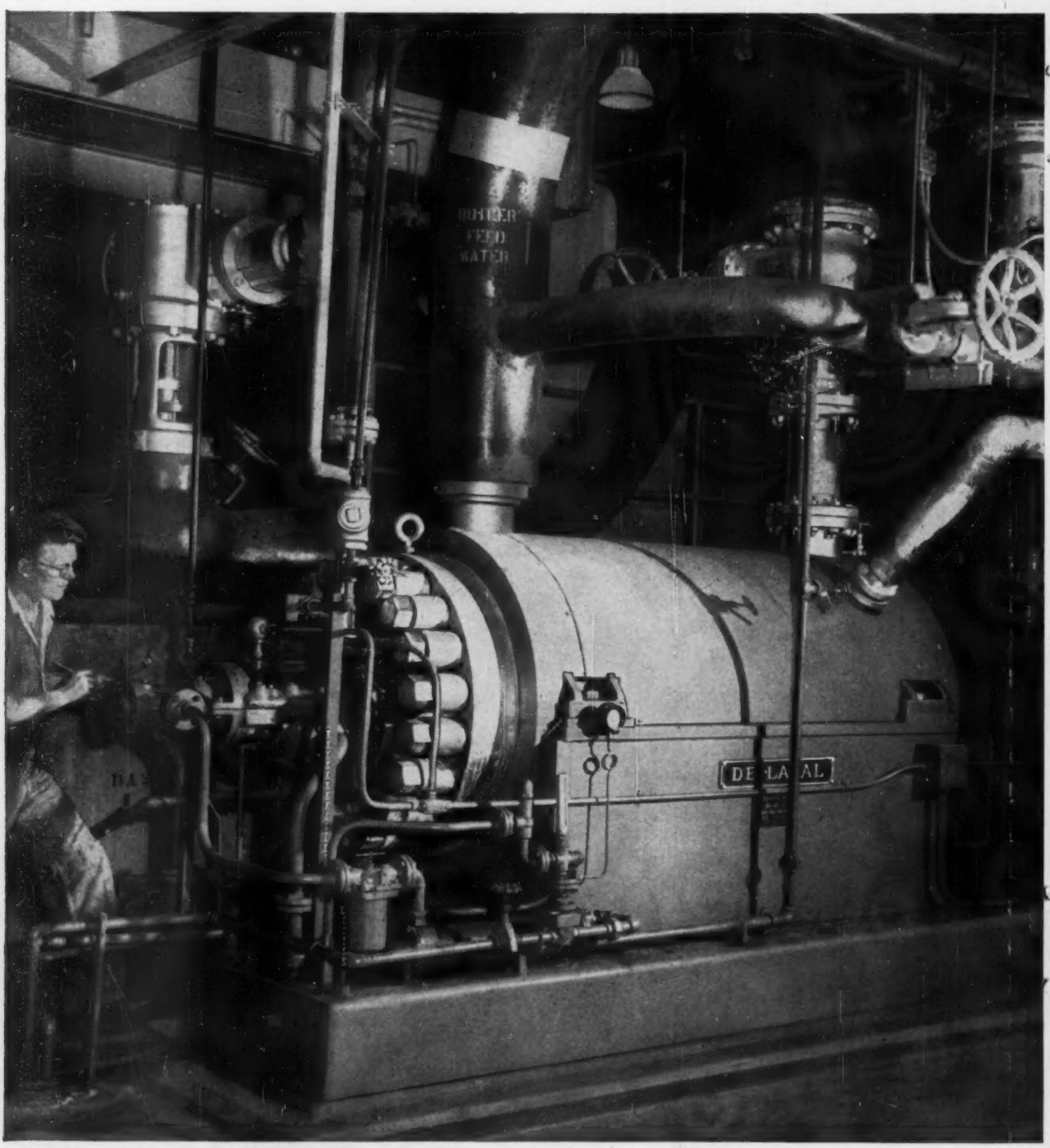
	Gold		Bronze	
	Yes	No	Yes	No
Offer co-op advertising allowances to builders	45	41	33	44
Offer installation allowances to builders				
Cash	25	52	17	51
Discount on appliances*	9	54	9	55
Other†	13	50	9	54
Offer any other special allowances to builders‡	48	28	32	31

* Three companies offer water heater discount

† Three companies furnish Housepower entrances, three offer wiring allowances, two offer electric heating allowances

‡ Advertising and promotional materials, lamp bulbs, wiring allowances, half the cost of portable lamps, $50 for electrically heated MH, water heater for home with electric heat

DE LAVAL Feed Pumps serve



latest unit at Central Hudson

Burns and Roe Inc., Engineers and Constructors, complete third unit at Danskammer Station

To meet increased load demand, Central Hudson Gas & Electric Corporation has added a 140,000 KW 2400 psig main unit at its modern Danskammer Steam Station. Providing dependable boiler feed service are two 2500 HP direct motor driven half capacity De Laval barrel type boiler feed pumps. The earlier units have De Laval full capacity variable speed boiler feed pumps.

← Each De Laval pump has intermediate pressure bleed off for use in controlling steam temperature from reheater.

Central Hudson's modern Danskammer Steam Station located at Roseton, New York on the Hudson River. ↓

DE LAVAL **STEAM TURBINE COMPANY**
861 NOTTINGHAM WAY, TRENTON 2, N. J.

DL-216

LABORATORY CONTROLLED...

Crapo

GALVANIZED STEEL STRAND FOR GUY, MESSENGER and OVERHEAD GROUND WIRE

The high, uniform, consistently-dependable quality of Crapo Galvanized Steel Strand is the direct result of close laboratory control over each step in manufacture. All wires used in forming a particular size and grade are produced from steel of selected analysis, carefully processed under technical supervision and stranded on precision machines. Both wire and finished strand are subjected to prescribed laboratory tests to insure the desired end result.

Heavy, uniform, tightly-bonded zinc coatings, applied by the famous *Crapo* Galvanizing Process, provide maximum resistance to corrosion.

Write for booklet OG-25 containing "Sag and Tension Data for Overhead Ground Wire."

INDIANA

STEEL & WIRE CO., INC., Muncie, Indiana

Medallion Home Survey

(*Continued from page* 105)

Who develops the new home market? In most companies the residential sales section does it. However some companies have established a special "builder section."

In 25 companies those people responsible devote full time to the new home market; 67 companies report it as a part-time job. The average company has the equivalent of 11 contact men and two staff or specialist men employed full time.

Many companies found it necessary to add or reassign staff members to handle the increased promotional job the program entails. Twenty companies reported "reassignment of duties," while 35 added manpower.

The builder is one of the key men in the Medallion Home promotion. And a majority of the responding companies offer various types of allowances to builders to encourage them to participate in the program. (See box on page 105.)

While some companies give no promotional allowances, the majority of the companies fall in the $150-300 range for Gold Medallion Homes, and $50-75 for Bronze. The maximum of any company is $675 for a GMH (this includes $500 for a demonstration home and $175 for purchase of service entrance) and $225 for a Bronze. The minimum: $20 and $20.

In development projects promotional allowance figures drop to $100-200 for Gold, while Bronze stays the same ($50 to $75).

Most builders feel public inspection is the way to sell. And all but nine utilities responding cooperate with builders on model home promotions. Fifteen companies have one to six cooperative model home promotions per year; 29 have 25-75, and seven have between 100 and 300.

But will the builder take just any kind of help or are there some forms which he feels will help him do the best selling job? Utilities say that the builders like advertising or advertising allowances and promotional help (37 companies), staffing and organizing open house activities (24 companies), and newspaper advertising (23 companies.)

Selling the builder and other trade groups is important but how about the customer—the ultimate buyer? One interesting fact in the survey results was the importance placed on home service personnel selling the MH concept. Seventy-five companies use home service to sell Gold Medallion homes; 65 to sell Bronze.

Newspapers are the most effective form of advertising in selling Medallion Homes, according to the survey. Eighty-five companies use newspapers, 62 use radio spots; 47, direct mail handouts; 44, TV spots; and 42, billboards or car cards.

The Medallion Home Program has brought about very little change in company policy. Only 21 utilities have instituted or changed any company policies. Capitalized service entrance, underground distribution policy, and liberalized line extension policy head the list.

But 64 companies made a change in rates to advance the all-electric concept. Thirty-eight put in a new rate, while 34 added budget billing.

Thirteen companies reported complete results which enabled comparative summarization for the last three years. These companies represent a considerable diversity as to size and geographic location, but the average kwhr and revenue per customer of this group compares closely with the US average. (See box on page 105.)

All is not sunshine and roses however. There are roadblocks to getting complete acceptance of the MH concept. Chief hinderance is difficulty in selling homeowners (31 utilities) while 24 utilities said it is selling the builder. Aggressive competition was mentioned by 18 companies.

The reasons builders are dissatisfied are because they don't like the MH standards, according to 17 companies; 13 said there is a lack of customer acceptance, and ten said the standards make it harder to sell the home. Some utilities found that while the builder has no serious complaints he is simply unenthusiastic.

But, 69 companies indicated their builders place real importance on the Medallion.

The homeowner is even more satisfied. Seventy-four companies said the owner places a high value on the Medallion.

THE WESTERN PRECIPITATION

"Transistomatic" CONTROL

BY FAR, the Industry's Most Advanced Precipitator Control...

NO TUBES! NO RELAYS! NO COUNTERS!

and carries a Lifetime Guarantee!

In the electrostatic precipitation of dust, fume and fly ash, no installation is completely modern without *automatic* control to maintain optimum Precipitator efficiency as the characteristics of the gas stream fluctuate. Compared with manual control, automatic control is not only more sensitive and more efficient, but actually costs less because of the vital savings it makes in labor and operating costs . . . *savings so important that no profit-minded operator will want to be without them.*

But the important point to remember is this—
Although many manufacturers of precipitation equipment offer units for precipitator automation, no other unit is equal to the "Transistomatic" Control for foolproof simplicity, rugged dependability or control accuracy!

These are not idle claims. They can be easily verified by making your own comparison . . .

A DESCRIPTIVE BOOKLET
that gives further information will gladly be sent on request. Write, wire or phone our nearest office!

Compare **ACCURACY!** The "Transistomatic" does not base its "sensing" action on spark *frequency* alone—or spark *intensity* alone. Instead, it continuously integrates BOTH frequency and intensity to establish an overall "power value" that provides a new standard of control accuracy!

Compare **DEPENDABILITY!** The "Transistomatic" unit contains no parts of any kind requiring regular replacement. Moreover, the entire unit is completely sealed—moisture-proof and watertight.

Compare **GUARANTEES!** The "Transistomatic" is so foolproof and trouble-free it carries a *lifetime guarantee!*

BEFORE YOU BUY ANY automatic precipitator control, be sure to get the complete "Transistomatic" story. A folder is available giving additional data. Or see your nearest Western Precipitation representative for further details!

WESTERN
PRECIPITATION
DIVISION OF JOY MANUFACTURING COMPANY

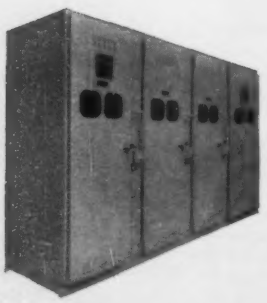
Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

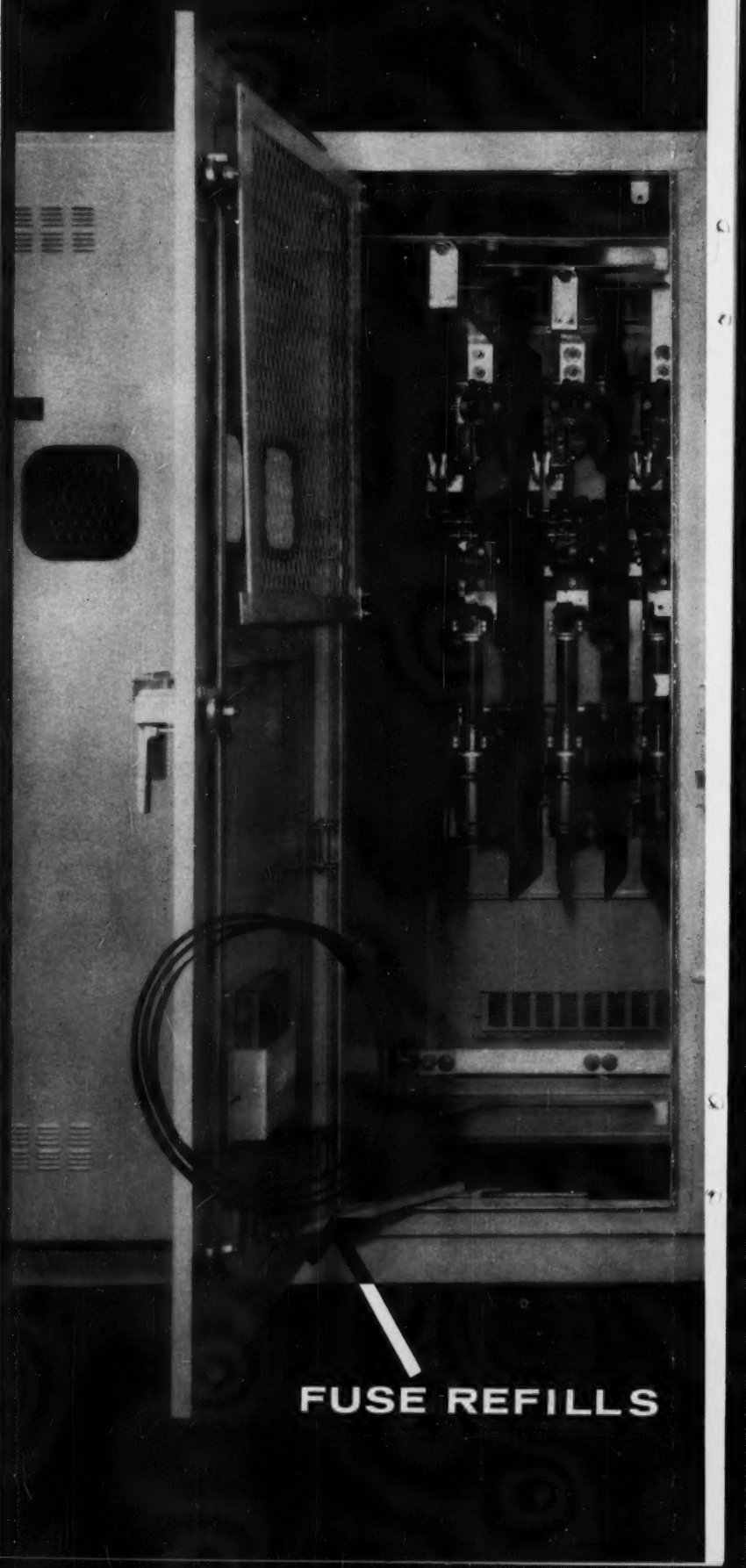
Representatives in all principal cities

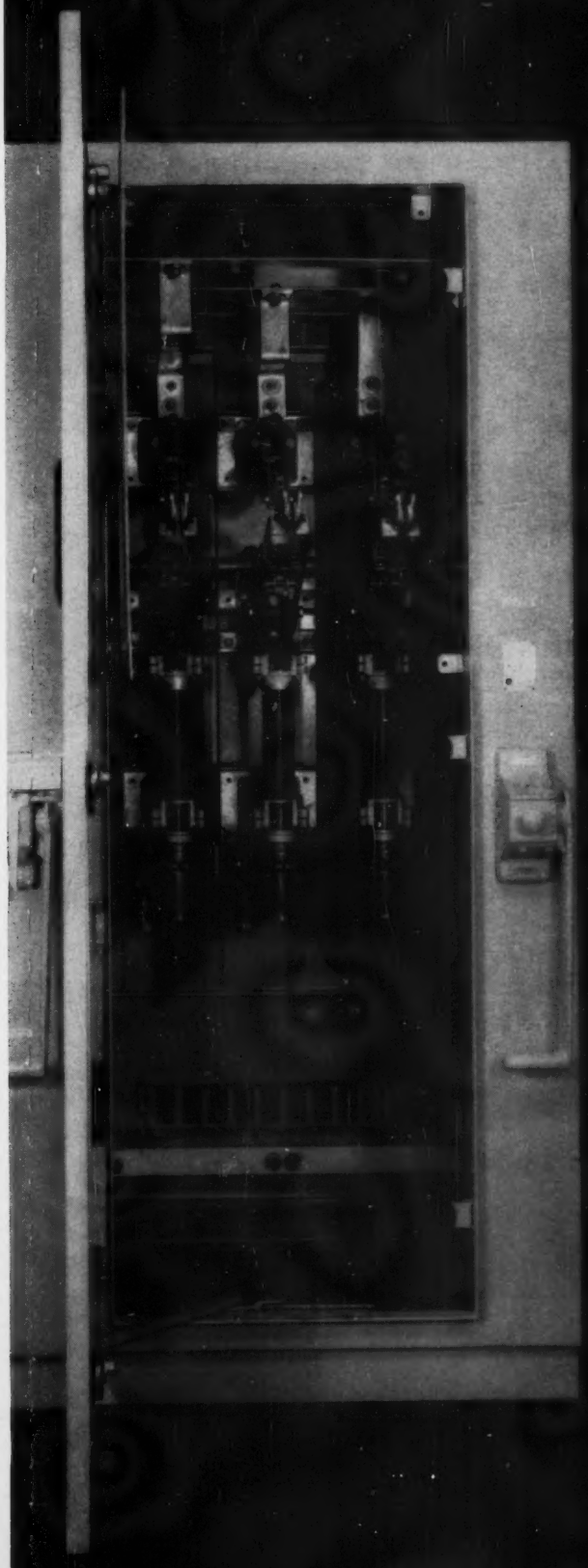
Precipitation Company of Canada Ltd., 8285 Mountain Sights Avenue, Montreal 9

HOW SIMPLE CAN YOU GET?



S&C metalclad switchgear meets all National Electric Code requirements for fault closing, short-circuit interruption. Performance proved by high power testing at KEMA laboratories.





S&C metalclad switchgear is easy to operate, easy to maintain, easy to understand

The simplicity of the fused interrupters in S&C metalclad switchgear means that everyone from the consulting engineer to the electrical contractor to the plant engineer and electrician saves time, money, and effort. The power fuses give positive and permanently accurate protection against faults. The load interrupters provide full load switching and can close on any fault up to 60,000 amps (at 4.16 kv). The power fuse in series with the load interrupter takes the mystery and high cost out of high-voltage switch-gear for industrial plants and for commercial and industrial buildings.

Costing roughly half the price of comparably rated circuit-breaker equipment, S&C metalclad switchgear protects high-voltage power supply circuits with self-sufficient power fuses. Permanent faults are detected without the complicated relay systems or instrument transformers required with circuit breakers. (Transient faults do not occur on industrial or commercial power supply circuits. Thus the expensive repetitive and automatic reclosing features of circuit breakers are not needed.) After the fault has been corrected, simply replace the blown fuse with a $13.50 refill stored right in the enclosure door.

Operating instruction and installation are simple with S&C metalclad switchgear. Nothing to set, adjust, exercise or check out. Plant personnel find it easy to understand and operate.

Why not consider S&C metalclad switchgear for your high-voltage (2300 to 15,000-volt) power systems? For more information, please consult the telephone directory for your nearest S&C sales office. Or write to:

S & C ELECTRIC COMPANY

4421 Ravenswood Avenue • Chicago 40, Illinois

Specialists in High Voltage Circuit Interruption since 1911

S&C

L.A. Water & Power General Manager Named

Samuel B. Nelson has been appointed general manager and chief engineer of the Los Angeles Department of Water & Power, succeeding William S. Peterson who retired.

Nelson, with the Department 34 years, has been chief engineer of the Department's water system since 1955.

In addition to his local duties, Nelson is water operating engineer for the California civil defense organization. He is also president-elect of the Los Angeles section of the American Society of Civil Engineers

◀ SAMUEL B. NELSON

Oklahoma Gas & Electric Makes Four Executive Appointments

Oklahoma Gas & Electric Co has made four executive changes:

• Andrew J. Haswell, a vice president, was given direct responsibility for Oklahoma City and western division operations as well as general responsibility for personnel administration in the six geographical divisions;

• Clarence W. Anthony, former executive assistant in operations, was promoted to vice president and given responsibility for transmission and distribution, generation, engineering, construction, and transportation;

• Vice President W. R. Wolfe assumed responsibility for sales, advertising and publicity, industrial development, rates and contracts, and airplane pilots and scheduling;

• H. H. Ferrin, vice president and treasurer, assumed responsibility for accounting and stores, budgets, liability and property insurance, ad valorem tax, and purchasing.

HASWELL

ANTHONY

Haswell was named director of personnel administration in 1947 and a vice president in 1957.

Anthony, with the company since 1935, was named operations executive assistant in 1955.

Galvin Is Boston Electric Institute Head

Edward F. Galvin, New England district manager for Simplex Wire & Cable Co, has been elected president of the Electric Institute, Inc, of Boston.

Also elected were: C. F. Werner of Brockton Edison Co as vice president; R. T. Custer of Graybar Electric Co as treasurer; J. A. Galvin of Boston Edison Co as secretary; and J. P. Twomey of Adams Appliance Co as assistant secretary.

◀ EDWARD F. GALVIN

(*More News About People on page* 114)

First Operational Reports in!

New '61 Larks in actual fleet service save 10% • 14% • 16% • 25% over other fleet cars

What should you expect to gain when you put '61 Larks into your own fleet? Here is a certified report by the United States Testing Co., based on daily use of The Lark under normal operating conditions in four giant fleets, including a major utility company:

All drivers were favorably impressed with the increased power and acceleration of the new Skybolt Six engine – the responsive, easy steering of the new steering/suspension complex – the excellent handling and maneuverability all through.

And the report makes specific cost comparisons with the most widely used fleet cars—Chevrolet, Ford, Plymouth, in comparable models. Here's what you save:

Initial cost **averages 14% less . . .** ***Insurance*** **(with Illinois as the basis) costs 10% less . . .** ***Registration and Taxes*** **(Illinois) are 16% less . . .** ***Tires*** **save approximately 15% . . .** ***Repairs and Replacements*** **(from MOTOR's 1960 Crash Book) average 25% less . . .** ***Gas Consumption*** **(based on 5,000 everyday drivers) was more than 15% better.**

These are unmatched advantages in economy. In fact, they top the savings on any other compact car as well. And they show you why each day's mail brings such Lark Fleet orders as 35 for a mid-western route sales operator, 566 for a western state, 134 for an eastern taxi fleet, 51 for one telephone company, 38 for a municipal Police force in the southwest.

THE '61 LARK BY STUDEBAKER

YOU HAVE TO DRIVE IT TO BELIEVE IT!

GET THE FULL STORY ON FLEET SAVINGS!

Fleet Sales Division, Studebaker-Packard Corporation, South Bend 27, Ind.

- ☐ Send us informative literature only
- ☐ Have a factory representative call me for an appointment
- ☐ Also send information on Studebaker truck savings

NAME _____
PLEASE PRINT

TITLE _____

COMPANY _____

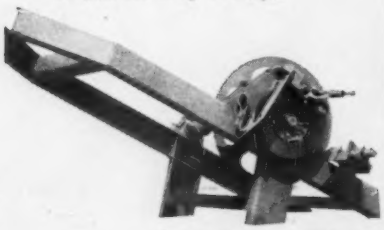
ADDRESS _____

EW 1-16-61-F6

Now—Convert your own Reel Dolly to a Bullwheel Tensioner
WITH A
PENGO
5000-U Assembly

5000-U assembly installed by City of Medicine Hat, Alberta, Canada

Here's an easy way to build up a modern bullwheel tensioner at low cost—simply install a PENGO 5000-U Bullwheel Assembly to your old trailer or reel dolly. You'll have a tensioner with Neoprene-lined 26" bullwheels, capable of handling practically any distribution line stringing job at tensions to 2,000 lbs. at up to 4 mph.



Support arms, reel spindle with reel brake, and hand rewind assembly. 2⅜" spindle will handle reels to 75" diameter, 44" width unless reduced to fit your trailer.

Bullwheel and tension brake assembly may be purchased separately.

We invite you to write or wire for literature, prices—please address Dept. 124.

PETERSEN
ENGINEERING COMPANY, INC.
Santa Clara, California
Phone: AXminster 6-7712

16

Dunn Named GE Vice President

Oscar L. Dunn has been elected a vice president of General Electric Co.

General manager of the motor and generator division since 1958, Dunn has been with GE since 1936 when he was graduated from Indiana University.

He held positions of progressively greater responsibility, becoming general manager of the direct current motor and generator department in 1953.

Greenhaus Becomes Sales Head

Fischer & Porter Co has promoted Lawrence R. Greenhaus (photo) to general sales manager. Reginald D. Schuler became director of technology, and Manuel J. Kauffman flowmeter division manager.

Greenhaus was formerly sales manager for Luria Engineering Co. Schuler has held directorial posts with several large corporations. Kauffman was formerly a district manager for Howe Scale Co.

McAleer Elected VP, Director

William S. McAleer has been elected vice president and a member of the board of directors of Peter F. Loftus Corp, design and consulting engineering firm.

McAleer was formerly vice president of McNally Pittsburg Manufacturing Corp, Pittsburg, Kan., designers and builders of plants and equipment for industry.

(*More News About People on page* 119)

OBITUARIES

Harry P. St. Clair, 65, retired consulting engineer for American Electric Power Service Corp of New York . . . **John C. Young,** 58, vice president and director, Texas Power & Light Co . . . **Francis A. Loney,** 66, manager, Philadelphia Electric Co claims division . . . **Robert H. Crone,** 60, engineering business development representative for Ebasco Services Inc . . . **LeRoy Engstrom,** 54, Tennessee Valley Authority river control branch chief . . . **John H. Tacke,** 61, construction engineer with Kaiser Engineers . . . **Carl E. Hoelz,** 59, product manager for protective equipment, Line Material Industries division of McGraw-Edison Co . . . **Frank Quinby,** 70, retired superintendent of electrical maintenance, Bonneville Power Administration . . . **John F. Lowrie,** 42, supervisor, Philadelphia Electric Co . . . **Raymond P. Stansbury,** 73, former general manager for customer relations, Baltimore Gas & Electric Co . . . **Joseph M. Costello,** executive vice president, South Carolina Electric & Gas Co . . . **Joseph Valentine Smith,** 76, retired board chairman, Hubbard & Co . . . **Daniel J. Gallagher Sr,** foreman, maintenance department, Philadelphia Electric.

How to combat these electrical raceway problems

GALVANIC CORROSION *USE RIGID STEEL CONDUIT.* Its zinc coating guards it thoroughly against corrosive action when buried in concrete or soil. And it is fully compatible with all common building materials.

ELECTRICAL FIRE HAZARDS *USE RIGID STEEL CONDUIT.* Because it has good conductivity, and positive coupling, steel grounds out induced and imposed currents without danger. The strength and toughness of steel protects wiring from physical damage.

SHORT SERVICE LIFE *USE RIGID STEEL CONDUIT.* Numerous installations over 50 years old are still in service; those going in today will be serviceable even longer.

EXPENSIVE UPKEEP *USE RIGID STEEL CONDUIT.* It outlasts any number of rewirings. Its tightly bonded zinc and enamel coatings remain attractive throughout its service life.

PROTECTION OF EXPOSED RUNS *USE RIGID STEEL CONDUIT.* The strength of steel resists damage from moving objects, thus providing electrical wiring with the most thorough and dependable mechanical protection available.

REWIRING DIFFICULTIES *USE RIGID STEEL CONDUIT.* Fish tapes cannot damage its smooth, hard interior, and wiring is easy to pull in. Easy to pull out and replace, too, even many years after installation. Altering the wiring system is simple and quick where spare conduit capacity has been provided.

HANDLING DAMAGE *USE RIGID STEEL CONDUIT.* Because of its great strength, steel conduit needs no special handling, no "babying." It stays round and straight, resisting damage from all but the most severe treatment.

SLOW DELIVERY *USE RIGID STEEL CONDUIT.* Good inventories of standard types and sizes of steel conduit and fittings are always maintained by pipe mills and electrical distributors. When you specify rigid steel conduit, you're sure to be able to get it when you want it.

SPECIAL INSTALLATION EQUIPMENT *USE RIGID STEEL CONDUIT.* Electrical contractors are used to working with steel conduit, and already own—and know how to use—the necessary installation equipment. Steel conduit requires no special tools nor handling techniques.

Steel

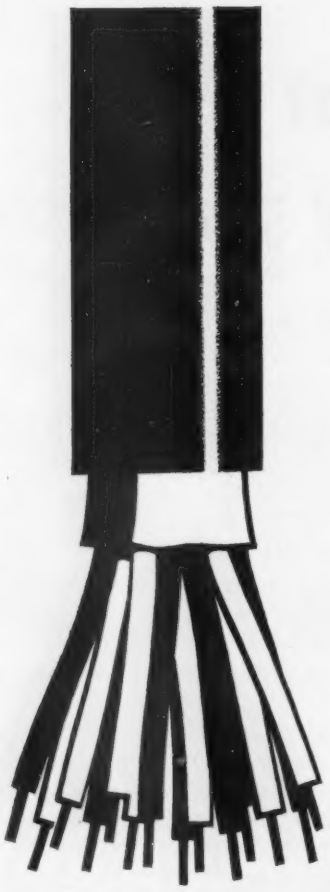
For strength
...economy
...versatility

First in wiring protection for over 50 years, rigid steel conduit is the strongest answer to all your electrical raceway problems. Your electrical distributor will be glad to supply the details. Ask him about steel conduit soon.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa.
EXPORT SALES: Bethlehem Steel Export Corporation

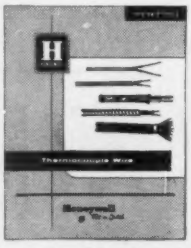
BETHLEHEM STEEL

BETHLEHEM STEEL



MULTIPLE-CONDUCTOR T/C EXTENSION CABLE

Available with from 4 to 48 pairs of solid-conductor temperature-compensated wires. Each wire is numbered, individual conductors are twisted into pairs, each pair is color-coded by wire type. No conduit needed. Supplied in custom and standard constructions. From this one dependable source come thousands of other accessories to help your instruments perform at their very best.



Get details from your Honeywell field engineer, or write today for Catalog G100-2.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1906

Probes Capacitor Use

(*Continued from page* 46)

tests revealed need for low-voltage protectors on the CT secondaries in addition to the initial primary protectors. This bank, said Deloney, doubled the effective loading on a $3-million transmission line at a cost of only $500,000.

A capacitor switch generally must be capable of withstanding appreciably higher peak values of recovery voltage than are encountered in resistive switching. Except for the small transient component of the recovery voltage, the rate of rise of capacitive recovery voltage is slower than that encountered in resistive switching. The difficulty in switching capacitors, said J. W. Rittenhouse, Hi-Voltage Equipment Co, lies in the total electric charge trapped in the capacitor which is very quickly dumped back into the interrupter when a restrike occurs, producing an exceeding high current in the arc. Thus, most vacuum switches have been installed for capacitor switching because of the extreme ease with which they interrupt capacitive loads without damaging restrikes.

Standardized hardware soon will be available for low-cost automatic recording of system measurements in a format suitable for entry into a utility's data processing system, said I. H. Peak, Sangamo Electric Co. This need can best be met through use of the simplest substation data logger, leaving such functions as point identification, square root extraction, and application of multiplying factor to the central data processor. Such standardized hardware will cost $100 per average measurement point without a transducer and $200 including a thermal demand transmitter.

One benefit of metering, said C. A. Mast, Central Power & Light Co, has been the ability to evaluate more accurately excess reactive supply at off-peak periods. Against a tendency to install a large number of switched primary capacitors during years of rapid system growth, the company increases the ratio of fixed to switched banks, he said. Graphic kw and kvar demand meters in larger substations meter about 70% of the load. For 12.5-kv feeders, standard permanently wired test blocks are used for porta-

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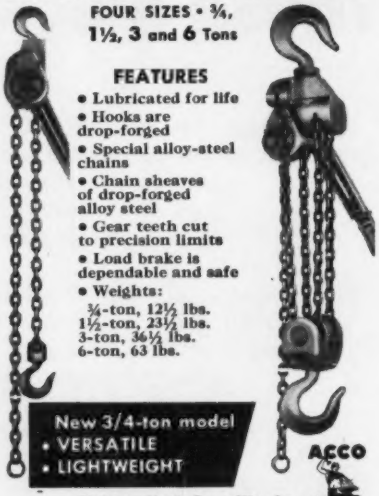

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ble kw and kvar graphic demand meters. Test blocks cost about $35 per feeder, installed, and are factory installed on new OCB's. Portable combination meters cost about $365, including leads, plugs and labor.

A system-wide approach has proved very effective in planning reactive supply, reported T. W. Schroeder, Illinois Power Co. Furthermore, a computer study, occasioned by a large increase in vars from generating stations and interconnections, promises to give an optimum answer to how many vars should be installed annually on each component of the system. Var requirements are reviewed annually by using a "load flow diagram" drawn semi-annually for the entire transmission and subtransmission system from special readings of voltage, kw and kvar flow during summer and winter peak load periods. Distribution var needs are determined from readings of portable var recording instruments connected to test positions on feeder control panels, he said.

Discussion at the seminar compared the practice of maintenance of primary capacitor bank switches. Mast stated that CP&L's policy is to service the switches every two to three years because of salt contamination, but he suspected this may be too often. Peterson said that the city of Austin changes out and checks switches every two years. West Penn Power Co, reported H. W. Prinkley, has a maintenance program based on either an elapsed-time basis or a maximum number of operations in less than this period. Louis R. King said that California Electric Power Co uses a number of operations as a guide to maintenance and determines whether the voltage band width is too narrow.

•

UPDATE DAM PLAN—A 22-year-old plan for a $52-million dam on New River is being modernized and studied by area leaders in Virginia. Details of the plan, updated by the Army Corps of Engineers, were submitted to the Carroll-Grayson Chamber of Commerce which will appoint a committee to study the economic advisability of the combined flood-control and hydro project.

put up an improperly designed photocontrol, and it's also just a question of time.

Apparently no one got a good look at the specs for the Pisa tower — or maybe the mayor was the architect's uncle. Who looks at the specs of the streetlight controls *you* buy and put up in the thousands — and what proof does the vendor offer to back them up? Time will supply the answers, if your source doesn't. The Fisher-Pierce Co., 82 Pearl St., So. Braintree 85, Massachusetts.

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PERSONAL BRIEFS

Jersey Central Power & Light Co has promoted **Frank Misch** to right-of-way agent.

Kenneth Summers has been named president of the board of directors of Clearwater Power Co, REA co-op at Lewiston, Idaho. He succeeds **P. J. Miller** who retired.

Baltimore Gas & Electric Co has appointed **Joseph H. Purdy** director of public relations. **Newell M. Calloway** succeeded Purdy as customer relations department manager.

West Penn Power Co has made **Rodger W. Murtaugh** manager of labor relations, **William S. Byrom** manager of personnel services, and **J. Vincent Soisson** director of marketing.

Montana Power Co has transferred **Walter R. Neumann** to Butte as assistant to the superintendent of power and generation.

Charles W. Allen Jr, vice president and a director of Belknap Hardware & Manufacturing Co, has been elected to the board of directors of Louisville Gas & Electric Co, replacing the late **Judge Arthur Peter.**

Ted Van Steenburg has succeeded **G. E. Blevins** who retired as Plant City division manager at Tampa Electric Co.

Lewis R. Gaty, vice president in charge of engineering and research of Philadelphia Electric Co, has been inducted as a professional member of Beta Alpha chapter (Drexel Institute of Technology) of Eta Kappa Nu.

American Electric Power Service Corp has promoted **Verne A. Sechler** to the industrial sales division in New York. He was succeeded by **Walter R. Ankrom** as Ohio Power Co industrial sales supervisor.

Central Illinois Public Service Co has named **Harland G. Grim** substation engineer of the electrical department substation section in Springfield, and **Robert R. Logan** substation engineer for southern division operations.

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Electric Utility Engineer in a government agency. Salary approx. $8,000. Location —New York City. Qualifications: PE License and 3 years electric utility experience or the equivalent. P-5909, Electrical World.

U. S. Government

DEPARTMENT OF THE INTERIOR, Bureau of Reclamation. Sealed bids (Invitation No. DS-5471) will be received at Denver, Colorado, until 2 p.m., Mountain Standard Time, February 21, 1961, for furnishing two 30,000/40,000/50,000-kva, 3-phase, 154- to 69-kv triple-rated autotransformers; and one 75,000/100,000-kva, 3-phase, double-rated, 69-kv, voltage regulating transformer for Denison Substation, Missouri River Basin Project, Missouri-Oahe Division. Delivery is desired within 345 days. For particulars, address Bureau of Reclamation, Building 53, Denver Federal Center, Denver 25, Colorado. Floyd E. Dominy, Commissioner.

DEPARTMENT OF THE INTERIOR, Bureau of Reclamation. Sealed bids (Invitation No. DS-5474) will be received at Denver, Colorado, until 2 p.m., Mountain Standard Time, February 23, 1961, for furnishing one 30/40/50-mva, 154- to 69-kv, 3-phase, triple-rate autotransformer and one 37.5/50-mva, 3-phase, 69-kv, voltage regulating transformer for Creston Substation Stage 01, Missouri-Oahe Transmission Division, Missouri River Basin Project. Delivery is desired within 345 days. For particulars, address Bureau of Reclamation, Building 53, Denver Federal Center, Denver 25, Colorado. Floyd E. Dominy, Commissioner.

DEPARTMENT OF THE INTERIOR, Bureau of Reclamation. Sealed bids (Invitation No. DS-5477) will be received at Denver, Colorado, until 2 p.m., Mountain Standard Time, February 16, 1961, for furnishing one 69-kv, 50,000/66,667-kva, 3-phase voltage regulating transformer for Grand Forks Substation, Missouri River Basin Project, North Dakota. Delivery is desired within 150 days. For particulars, address Bureau of Reclamation, Building 53, Denver Federal Center, Denver 25, Colorado. Floyd E. Dominy, Commissioner.

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Meetings Calendar

JANUARY

Edison Electric Institute—Electric Space Heating & Air Conditioning Committee, New Orleans, Jan. 23-24; Industrial Power & Heating Group, New York City, Jan. 26-27.

• **Missouri Association of Municipal Utilities**—Meter School, University of Missouri, Jan. 23-24.

Canadian Electrical Association—Eastern Zone, Nova Scotian Hotel, Halifax, N. S., Canada, Jan. 23-26.

Plant Maintenance & Engineering Show—International Amphitheatre, Chicago, Jan. 23-26.

Southeastern Electric Exchange—Legal and Claims Committee, Roney Plaza Hotel, Miami Beach, Jan. 25-26.

Pennsylvania Electric Association—Personnel Practices Committee, Philadelphia, Jan. 26; Communications Committee, Pittsburgh, Jan. 26-27; Stores Committee, York, Jan. 26-27; Structures and Hydraulic Committee, Benjamin Franklin Hotel, Philadelphia, Jan. 26-27.

American Institute of Electrical Engineers—Winter General Meeting, Hotel Statler, New York City, Jan. 29-Feb. 3.

American Society for Testing Materials—Committee Week, Netherland Hilton Hotel, Cincinnati, Jan. 30-Feb. 3.

FEBRUARY

• **Edison Electric Institute**—Commercial Cooking and Water Heating Committee, Atlanta, Feb. 1-2; EEI-AGA Accounting Conference Final Working Meeting, The Brown Hotel, Louisville, Feb. 2-3; Commercial Lighting Committee, New York City, Feb. 6-7; Prime Movers Committee, Dinkler-Tutwiler Hotel, Birmingham, Feb. 6-8; Taxation Accounting Committee, Deshler Hilton, Columbus, Feb. 8-10; Electrical System and Equipment Committee, Chase-Park Plaza Hotel, St. Louis, Feb. 13-14.

Intermountain Electrical Association—Annual Convention, Hotel Ben Lomond, Ogden, Utah, Feb. 2.

• **Pennsylvania Electric Association**—Land and Land Rights Committee, Philadelphia, Feb. 2-3; Prime Movers Committee, Pittsburgh Hilton Hotel, Pittsburgh, Feb. 2-3; Transmission and Distribution Committee, Penn-Harris Hotel, Harrisburg, Feb. 8-9; Motor Transportation Committee, Harrisburg, Feb. 9-10; Systems Operation Committee, Harrisburger Hotel, Harrisburg, Feb. 9-10; Electrical Equipment Committee, Pick-Roosevelt Hotel, Pittsburgh, Feb. 16-17; Taxation Committee, Philadelphia, Feb. 16-17; Purchasing Committee, Philadelphia, Feb. 20; System Planning, Philadelphia, Feb. 20-21; Relay Committee, Pittsburgh Hilton Hotel, Pittsburgh, Feb. 23-24; Plant Accounting and Records, Philadelphia, Feb. 23-24.

National Electrical Week—Feb. 5-11.

Electrical Manufacturers Exposition—Third Bi-Annual Meeting Veteran's Memorial Columbus, Feb. 7-9.

National Rural Electric Cooperative Association—Annual Convention, Hotel Adolphus, Dallas, Feb. 13-16.

American Society of Heating, Refrigerating & Air-Conditioning Engineers—Semi-Annual Meeting, Conrad Hilton Hotel, Chicago, Feb. 13-16.

Electrical Trade Conference & Exposition—Sponsored by Electrical Institute of Washington and the Electrical Manufacturers Representatives Association of Baltimore, Sheraton-Park Hotel, Washington, D. C., Feb. 14-16.

• **American Public Power Association**—Engineering & Operations Workshop, Colorado Springs, Feb. 16-17.

• **Southeastern Electric Exchange**—Accident Prevention Committee, Buena Vista Hotel, Biloxi, Miss., Feb. 16-17.

• **Missouri Valley Electric Association**—Industrial and Commercial Sales Conference, President Hotel, Kansas City, Feb. 16-17.

• **Upper Midwest Electrical Industry Convention**—Leamington Hotel, Minneapolis, Feb. 19-22.

• **National Wiring Bureau Sales Conference**—17th Annual Meeting, Sherman Hotel, Chicago, Feb. 23-24.

MARCH

• **Southern Safety Conference & Exposition**—Atlanta Biltmore Hotel, Atlanta, March 5-7.

• Additions this week.

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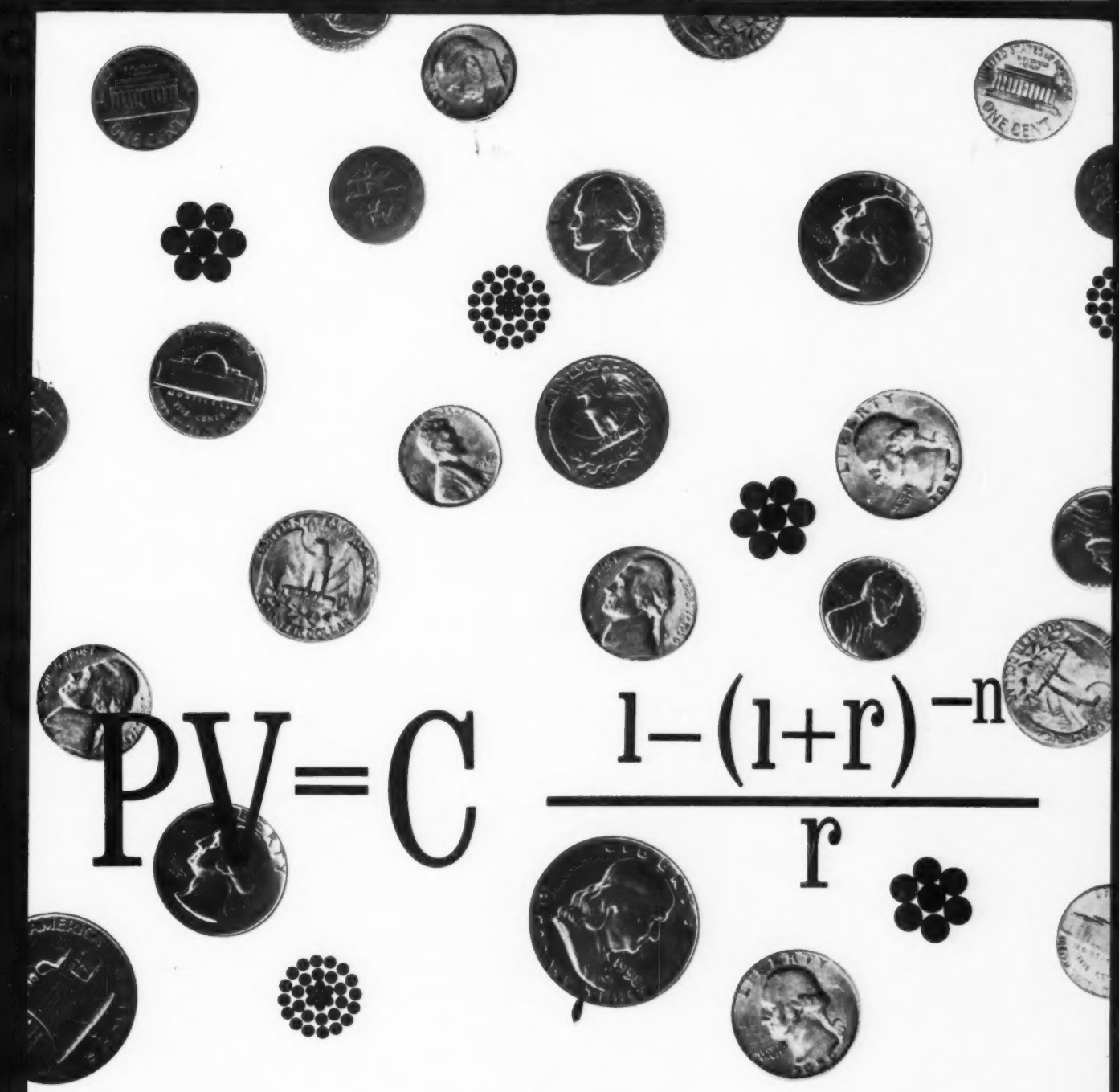

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